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No 1

ROLLIN HOWARD STEVENS

AN ANNIVERSARY CHRONICLE OF HIS USEFUL LIFE

By PERCY BROWN, M D , *Boston*

ONE of the most active and vigorous figures in the practice of American radiology to-day is that of Dr Rollin Stevens, who now reaches the age of three score years and ten prophetically signalized in Scriptural writ, and whose enthusiastic, sedulous, and forthright individuality, crystallized in the service of mankind and polished by the gentle contact of each passing year, continues to reflect from its many facets his faith in his work and in himself in the doing of it, as well as the joy of fulfilment which the realization of his life's ideals has assured to him

Rollin Stevens is a native of Canada, born of sturdy Anglo-Saxon and Celtic stock into the best traditions of the great Dominion at Blenheim, Province of Ontario, in early January of the year 1868. The eldest son of Nathan Howard and Ada Jane (Burk) Stevens, he lived with his parents at his birth-place until five years old, when the family removed to the far western community of Pilot Hill, California, in the placer-mining district of the Sierras. His father remained in California but a relatively short time, ultimately leading back his household to the Canadian village of Blenheim and later, in 1880, to the larger town of Chatham, Ontario. By reason of his seniority in a family

group of nine children, eight of whom were boys, the youthful shoulders of this lad carried, as they grew, more than the usual weight of the responsibility imposed by the duties of home life and the care of those younger than he. Notwithstanding his ardent participation in the various sports and pastimes, especially those of winter, wherein Canadian youth habitually excel, through this salutary family training young Stevens developed a sense of obligation and accountability, acquired a fondness for hard work and formed the sound attributes of character which have ever identified all phases of his life's endeavor.

By the time he was eighteen years old, Stevens had matriculated at the University of Toronto in preparation for the academic degree and subsequent study of the Law in accordance with parental plan, but during the year 1886 he was induced by a young friend of about his own age¹ to enter the Homoeopathic Medical College of the University of Michigan, from which he was graduated in 1889. Throughout the course of his later years in medical school his extra-curricular activities were increased—in junior year as Secretary of the Hahnemannian Society and in

¹ Now Dr. Duncan I. Sinclair, of Woodstock, Ontario

senior year as its President and also President of the Homoeopathic Branch of the Students' Christian Association. During the course of his senior year he was also Senior Assistant to the Professor of Surgery. His summer holidays were spent as coadjutor in the office of a private practitioner of St Thomas, Ontario, where his training profited by the practical experience afforded him. While yet a student at Ann Arbor, Stevens took advantage of the opportunity to present himself for the examinations of the Medical Council of Ontario, which he duly passed, thus qualifying himself for the practice of medicine in his native Dominion of Canada, should the occasion arise.

Upon his graduation from medical school, young Doctor Stevens fully determined to enter into practice in one of the (then) more recently founded Canadian communities, the city of New Westminster in British Columbia, but, hearing of an approaching competitive examination for the position of intern at The Grace Hospital, Detroit, he offered himself as a candidate. No doubt the divers interests of his undergraduate medical course and the moderate responsibilities attaching to them did much to develop a naturally active mind at its formative period, for we are told by a surgical colleague who was the first House Surgeon at The Grace Hospital² in reference to this examination, that " Dr Stevens received the appointment. Dr Sterling, who was the Chairman of the Examining Committee, said that the alertness of Dr Stevens' mind as much as the results of the examination papers influenced them in the decision. That alertness seems to me to have been a characteristic of Dr Stevens ever since." As the resident staff of The Grace Hospital consisted, at that day, of but one man, Stevens' duties were especially arduous during the first eight months of his appointment, after which the number of house-officers was increased to two. Doctor Stevens' internship at The Grace

Hospital was completed late in the year of 1891. It was followed by a journey with his father to California, by way of the Canadian Pacific Railway. Impressed by the opportunity for post-graduate study at the recently established Leland Stanford, Jr., University, the young physician finally succeeded in inducing his fiancée, Dr Mary Ella Thompson, to accompany him there on a honeymoon journey. Doctor Thompson was a young graduate in Arts and in Medicine, also a Canadian, whom he had met at Ann Arbor and who had opened an office in Detroit in the Autumn of 1889, just before he had decided to take the examination for The Grace Hospital. Accordingly they were married in March of 1892, journeyed West, and commenced post-graduate work at Palo Alto in physiology and pathology, which was continued until autumn, when they returned to Detroit to open offices in their domicile on High Street, West. With this wedding journey into the far West began a consistently happy companionship that has been ever fortified by a compatibility of tastes derived from a unifying analogy of educational equipment, and exceptionally blessed by mutual affection and sympathy steadily augmented with the passing years.

His entry into private practice was an experience not wholly new to young Doctor Stevens. He had already acted as *locum tenens* for medical colleagues of his who were at work in various towns of Ontario, for which his previously acquired license to practise within the Dominion stood him in good stead. Once established in Detroit, he immediately identified himself with the clinical activities at The Grace Hospital, and was placed on the Clinical Staff in Gynecology. When, later, he received his appointment to the regular Staff, he became successively pathologist, surgeon, and gynecologist during the period from 1892 to 1904. His thorough pathological experience, thus early acquired and amplified by additional work in weekly periods at Ann Arbor, afforded him the *sine qua non* for his fu-

² Dr Stephen H Knight, *personal communication*



DR ROLLIN HOWARD STEVENS

(1) In 1885 The year preceding his entrance to the University, (2) In 1889 At the time of his graduation (3) In 1890 When an intern at The Grace Hospital, (4) In 1899 When in general practice in Detroit, (5) In 1903 At the time of his visit to Copenhagen, (6) In 1910 When teaching at the Detroit College of Medicine (7) In 1914 At the outbreak of the Great War, (8) In 1917 At the time of America's entry into the War (9) Doctor Stevens at the present day

ture activity in the broad and ever broader fields which were spread before him as the first years of the Twentieth Century approached. The colorful history of his multiple and diverse labors at The Grace Hospital is the ample record of the fruition of the mental alertness originally noted by his internship examiners years ago, and as clearly manifested to-day in the "physical and mental youthfulness and agility"—as one of his biographers puts it—that are still his.

Always keenly alive to each fresh advance in scientific progress, whether or not related to his work of the moment, Doctor Stevens had shared the general intense interest among scholars created by Röntgen's *Preliminary Communication*, "On a New Kind of Rays," but perhaps he was attracted more than many others by the results reported soon after this by Professor Finsen, of Copenhagen, in the light treatment of variola and especially of dermal cancer and tuberculosis. As time passed thereafter, his acute sense of justice rebelled at the implications involved in the production and exploitation, especially in America, of so-called Finsen therapeutic apparatus from which the results obtained were most disappointing. Desiring, as he shortly afterward wrote, "to protest against the common practice of denominating as Finsen lamps any kind of a phototherapeutic lamp, the construction of which may involve only a few, or none, of the principles enunciated by Finsen," he journeyed by rough passage to Copenhagen in December of 1902 to investigate for himself and to evaluate to his own satisfaction the Finsen method of treatment. At the Finsen Institute Stevens spent many months as student and observer, and was given all possible clinical opportunities for his work. He ultimately returned with the accurate information equally available to any of his countrymen taking equivalent pains to investigate, although many others, visiting Copenhagen on but a short mission of investigation and brief instruction, relinquished in the disappointment of inepti-

tude all subsequent use of the Finsen lamp. On his return Stevens reported, and reiterated in a series of communications which constitute the earliest of his writings on radiological matters, that the secret of the Finsen treatment lies in the use of the highly refrangible blue and violet rays *supported and enhanced* in their effect by the addition of the ultra-violet. In the same series of papers he analyzed the structural shortcomings of a number of lamps produced prior to 1904 and purported to possess the same therapeutic effect as the Finsen apparatus. This persistent investigation at distinct personal sacrifice, and honestly accurate exposition of a truly beautiful and effective means of curing "superficial skin diseases that are suitable for it," had definite effect in dispelling "much misunderstanding as to the nature of the true Finsen light treatment and as to what it will accomplish," but even greater influence in arresting the manufacture of spurious apparatus offered to the unsuspecting practitioner for what it was not.

This pilgrimage of quest to the Finsen Institute may fairly be said to mark a distinct turning-point in the career of Dr. Rollin Stevens. He saw an opportunity to clarify an uncertain situation regarding a conceivably excellent measure in danger of undeserved misrepresentation, and seized it. The untoward influence of such obloquy atrophied and died in the face of the clinical results obtained from the veritable Finsen process in his hands at Detroit, or in the hands of those whom he had trained to have patience enough to employ it accurately.

In Denmark, Stevens saw enough of the beneficial effects of well-ordered phototherapy to revive within him a long-latent interest in dermatological problems. Before his return to Detroit he visited the clinics of Lassar and Joseph in Berlin, of Neumann in Vienna, of Unna in Hamburg, and of Sequeira in London. At the same time, the clinical possibilities of roentgen therapy and of radium therapy had had their day of dawning and were rapidly de-

veloping A vast new field was spread before the clear vision of Rollin Stevens and on his arrival at the scene of his long and varied professional labors, he determined to confine his endeavor to the practice of dermatology and radiology

To this end, Doctor Stevens forthwith equipped his offices with Finsen apparatus of the true Copenhagen type, for roentgen rays in the form of the static machine and for the therapeutic application of the high-frequency current He was transferred to the Dermatological Staff of his hospital and in 1904 formally appointed Dermatologist and Roentgenologist as well as Lecturer on Dermatology to the Homoeopathic Medical College of the University of Michigan The sincerity of his belief in the future of roentgen therapy, as well as the continued evidence of his thorough honesty of purpose, convinced the hospital authorities of their need of roentgen apparatus adequate to his purposes and theirs, for his use and under his responsible control But the winning of this concession was no easy accomplishment, a true picture, indeed, of the typical experience of the conscientious early pioneer in radiology and, as in the case of many another in the same field, it was by no means the end of the difficulties in his path It is related by his most steadfast supporter and at the same time his most just critic,³ that "for years he was almost alone in [his] recognition of the great value of both x-ray and radium in skin and cancer work Many times he returned to his home completely heartsick after reading a carefully prepared paper on the subject, only to have it almost completely ignored while the loud acclaim went to someone who described a new method or posture for a roentgenogram of the stomach "

In the Summer of 1903, Doctor Stevens obtained his first radium from the Curie laboratory in Paris, and thus, it is reported, he was the first practising physician west of New York to employ radium

therapeutically Consequently he was of the American pioneer group of such men as Abbe, Williams, and Robarts who early investigated practically its curative powers In 1905 he made his first recorded contribution to the literature of radium With characteristic loyalty to his ideals of truth and justice, he scrutinized, and promptly evaluated at their true worth, the reports prevalent at that day concerning water and other substances made secondarily radioactive for alleged therapeutic purposes It is difficult to conceive of one who, through his own moral fiber, could have been a more worthy champion of intellectual honesty in counteraction against not only the reckless hyper-enthusiasm but also the upstart charlatanism which this period brought forth

Stevens fought this situation for years Writing in 1914 on "Progress in Radiotherapy," in the spirit of complete equity typical of him he deals with his failures as freely as with his successes in all forms of radiotherapeutics, and attempts definitely to stabilize this tendency toward unconsidered optimism arising from too hasty observation Regarding the use of the gamma rays of radium, he records these temperate words of caution

"We must not forget that in secondary growths we undoubtedly have cancer widely spread in the organism—in the spine or other bones quite early in a large proportion of cases—so that while, in the treatment of a small visible or palpable nodule in the axilla or supraclavicular region, a small tube or plaque of radium may cause the nodule to disappear, it has had no very real effect upon the disease

"I emphasize this point because at least two cases of secondaries after breast amputation have recently come to my notice where just this sort of treatment has been followed, and twenty to thirty thousand dollars' worth of radium was applied to visible nodules by men of standing *while hope was held out* This will soon bring radium into disrepute "

The reaction which Stevens thus sagely prognosticated as the certain result of the disillusion and disappointment to follow the inevitably unfavorable outcome of such ill-ordered treatment was, indeed,

³ Dr Mary Thompson Stevens, *personal communication*

soon to appear During the same year of 1914 in which this unpretentious report and far-sighted prophecy were written, and *sixteen years* after the discovery of radium, the following editorial appeared in a medical journal of wide circulation under the caption "The New Quackery" Its quotation here is justified only on expository grounds, in order that the radiologist of to-day may realize the type of adverse criticism to which early radiology was subjected in a spirit born either of temporary clinical disappointment or of no clinical experience at all, as well as the magnitude of the task in rebuttal set before Stevens and other pioneers of the same fiber

"Radium is the Philosopher's Stone in its newest form What the alchemists and necromancers eagerly sought our new philosophers have found The profession of Medicine is now disposed to ask of the philosopher not what he says but what he can prove

Any new half-truth in Medicine is quickly seized upon with enthusiastic ignorance to benefit the sick, or with cunning design to impose upon the credulous All quackery does not lie outside the boundaries of the medical profession, and it is hard to distinguish between credulity, pretence and charlatanism

"For the moment sera are enjoying a respite Their place is now occupied by radium, and reputations of a kind are being erected upon it The moment is well chosen The public mind is blinded by the glamour of the emanations which issue from this substance, and no discovery was ever made which was not instantly seized upon for therapeutic purposes All that can be said at the moment is that the emanations from this metal do exert some effect upon cell activity, but the same is true of the ultra-violet rays or even of light itself Already reports of bad omen are coming in of healthy tissue destroyed and of connective-tissue cells being stimulated into a sarcomatous growth "

The effect of immaturely considered dogma could be counteracted in but one way—by further observation and further experimentation and study The span of Stevens' career from that day to this has seen prodigious and unrelenting advance in all forms of radiotherapeutics, and we move forward with giant strides

It was six years before this extensive

report of 1914, on the subject of radio-therapeutic progress to that date, that Doctor Stevens suffered a temporary but serious interruption of his usually excellent health, which followed the exertion and exposure attending a late autumn journey by canoe into the back country of northern Ontario with one of his colleagues That he might regain his normal strength, a sea voyage was recommended So, in the Spring of 1909 he went to Europe for recreation and study In London, he visited the laboratory of Sir Almroth Wright to investigate further the matter of opsonic therapy With his habitual eagerness to prove to his own satisfaction the real value of each new method of treatment applicable to cutaneous disease, Stevens had previously contributed a preliminary report on his own experience with opsonic therapy in disorders of the skin and, later, a more complete exposition based on eight months' experience with it These were followed by a paper on the general subject of bacterial inoculations which appeared in the literature of 1909, possibly a result of his London visit In Paris, on this same tour, he saw Regaud and Lacassagne, and was received with equal cordiality by Sabouraud

Before leaving London, Doctor Stevens carefully examined the theory of Quinton concerning the therapeutic action of intramuscular injections of especially prepared sea-water, not only in affections of the skin, particularly psoriasis, but also in general debilitating conditions He later analyzed and evaluated this method of treatment in three papers which appeared in 1909, 1912, and 1913

The name of Dr Rollin Stevens has been intimately and influentially identified with the radiological treatment of cancer ever since the inception of this procedure His career has been actively associated more specifically with the changing phases of the roentgen therapy of this condition from the early day of its most superficial application The available references to his literary contributions on the subject of cancer comprise at least sixteen papers

from 1904 to 1935 One of the most elaborate of these (1917) deals with the state of the blood in cancer under the action of roentgen therapy Stevens therein discusses with ingenuity the question of the coincidence of reactionary lymphocytosis and roentgen therapy in the larger doses, submitting that the resulting general immunity, even though temporary, suggested by the presence of lymphocytosis may well be interpreted as one of the two-fold salutary effects of roentgen therapy in cancer

Doctor Stevens was profoundly moved, as were all thinking radiologists, by the unfavorable reports of 1920 and 1921 regarding the incidence of aplastic anemia resulting from the cumulative effect of repeated exposure to radio-active emanations Such untoward consequences were in direct line with his conviction, expressed years before, that occupational radiation, or therapeutic dosage of radiation, should be controlled by periodic blood examination as well as by continued inspection of the integument so exposed He was a strong protagonist of the world-wide movement among radiologists toward the standardization of roentgen-ray generation and especially of methods of protection This movement had its impetus, to which he added the force of his influence and wisdom, in the recommendations of the Roentgen-ray Protection Committee of the American Roentgen Ray Society, formulated in 1920 and finally adopted in 1922 These recommendations involved specifically the questions of apparatus standardization, filtration, accurate mensuration of dosage, periodic blood and basal metabolism investigation of operatives and periods of respite, all of which Stevens had previously emphasized

Particularly in the matter of apparatus has he been interested He first carefully watched each early advance in the development of radiotherapeutic devices, especially after the production of the hot-cathode tube of Coolidge, and has kept step with this evolution in connection with all installations under his charge His was the

second deep-therapy apparatus to be installed within the State of Michigan, the first having been an experimental model maintained by the General Electric Company at Battle Creek His enthusiasm for the adoption of new ways and means in cancer therapy apparently knows no bounds A 400-kilovolt generator was installed during the Spring of 1937 at his laboratory, but evidently the output potential of each new piece of apparatus he acquires can never quite keep pace with the peak E M F of this astounding man!

Doctor Stevens' editorial in RADIOLOGY six or seven years ago under the title "Cancer Institutes" revealed, in the reading, a new light on his long-range vision concerning the cancer problem and the most potent means ultimately to solve it One of them, he explained in this editorial, is the complete co-operation of trained experts chosen from various fields of scientific activity, notably surgery, pathology, radiology, biochemistry, and biophysics Such complete and effective co-operation can be attained, he felt, only through the construction, equipment, and endowment of a Cancer Institute, based on lines of equivalent completeness Stevens cited the various cities which then possessed institutes for the investigation of cancer, but deplored the fact that none of them had sufficient endowment He expressed the opinion that, if and when an endowment proportionate to the purpose were available, it should be organized and controlled by private philanthropy rather than by the state or municipality, in order that the control of Institute activities by politics might be obviated

To-day, Doctor Stevens has lived to see an organized movement to the end he visualized in 1931, thus far realized in the Congressional passage of Senate Bill No 2067, which is a joint bill combining the generous appropriations called for by the Maverick Bill and the Bone-Magnuson Bill This "will establish a National Cancer Institute and provide for the United States Public Health Service to aid and co-ordinate

research relating to cancer"⁴ While this development does not completely conform to Stevens' conviction that such an endowment should proceed from private philanthropy, it is so epochal in its promise as to become one of the deepest satisfactions of his useful life

During an installation of apparatus at his hospital laboratory in February, 1917, Doctor Stevens received accidentally the high-tension discharge from the terminals of a rotary converter. The shock rendered him unconscious and seriously affected his spine, from which injury he has never fully recovered. Those were "parlous times," it will be remembered, and shortly before this accident Stevens had made voluntary application for military service with either the Canadian forces or with the army of the United States at that time on the Mexican border—wherever roentgenologists were needed. When, in April, the United States entered the Great War and Base Hospital No. 2 was organized and recruited as a military unit, he was accepted and appointed as a Major of the Medical Corps to take charge of all bacteriological and x-ray work. When, however, the papers pertaining to his physical examination were reviewed at Washington, he was rejected. With business affairs arranged and uniforms made, his disappointment was bitter indeed. By the Summer of 1918 there was urgent demand for expert military roentgenologists for immediate service overseas. Stevens again volunteered and was promptly accepted, but his time in New York, the port of embarkation, was uselessly consumed in futile military drill and superfluous instruction. While there, he fell a victim to the severe influenza epidemic then prevalent and nearly succumbed. The Armistice was signed before his long convalescence was over.

Through all these years, except when interrupted by periods of illness or temporary absence from other causes, Doctor Stevens has faithfully fulfilled his duties

of teaching, which began in 1904 as Lecturer on Dermatology at Ann Arbor. His formal teaching of roentgenology commenced in 1910 as Assistant Clinical Professor at the Detroit College of Medicine, he still gives there the courses of instruction in diseases of the skin instituted by him in 1925. In 1929, he was Extra-mural Lecturer in Post-graduate Medicine at the University of Michigan. His interest in research and research-teaching has been equally lively. He has been Secretary and also Director of the Radiological Research Institute. From the opinions expressed by those who have sat beneath his rostrum, or from the experience of those—interns, nurses, technicians—who have been in daily clinical contact with him, or from the joyous reaction of little children by the evening lamplight or in the open fields of summer, it is clear that Dr. Rollin Stevens is a teacher "to the manner born."

One of the notable features of the career of this altruistic physician is his loyalty and devotion to the welfare of the organized groups of medical men with which he is affiliated. He is an outstanding member of all four of the major American radiological associations—indeed, he has most worthily occupied the presidential chair of most of them. He became a member of the American Roentgen Ray Society but four years after the date of its organization, he is, therefore, one of its fourteen senior members, according to its present roster. He identified himself closely with the foundation of the Radiological Society of North America and was elected its President in 1924. He was President of the American Radium Society in 1933-34. He was active in the formation and organization of the American College of Radiology, of which he was a Chancellor from 1926 to 1929, its President in 1930-31, and again Chancellor from 1931 to 1936. Seemingly never to become surfeited with the myriad cares and responsibilities of almost continual executive office he has thus filled from year to year, the records show

⁴ *The Bulletin of the Inter-Society Committee for Radiology*, August 1937.

that his management has been always effective, his judgment sound, and his decisions wise

Doctor Stevens was one of a group of some fifteen representative American radiologists formed by himself in 1933 at the request of the American Medical Association to establish an American Board of Radiology for the purpose of standardizing the qualifications of specialists in this field. The labor involved in appointment to this Board is of a degree almost Herculean, Stevens' capacity for work, his tenacity of ideals and at the same time his tact and sense of fairness, may well be taken as the reasons for his recent re-appointment to this Board for a term of six years.

Besides these activities, he is, of course, a Fellow of the American Medical Association and a member of his State and County Medical Societies, a Fellow, also, of the American College of Physicians. Other associations devoted to his two specialties of which he is a member are the Detroit Roentgen Ray and Radium Society, whereof he was President in 1926, and the Detroit Dermatological Society, over which he presided in 1927. The Canadian Radiological Society and the Chicago Roentgen Society have each made him an Honorary member.

In view of this brilliant record in the name of professional fellowship for the loftiest of ideals, one might think that Dr. Rollin Stevens has no added time, no reserve strength, for active and perhaps equivalent endeavor outside his chosen fields in Medicine. If such is his belief, let him consider other conspicuous facts in the history of this extraordinary man which, in addition, vividly exemplify his deep sense of personal civic duty, his solicitude for the social welfare of others, his unflagging interest in matters involving the public health. Evidence of all these qualities is revealed in the conception, foundation, and evolution of the Detroit "Ford Republic," a Home for delinquent boys named in honor of its generous benefactors, the late Mrs. E. L. Ford and her

daughters. To this institution, which today produces results that are everywhere acknowledged, Doctor Stevens has given much time and great effort. To him its remarkable and renowned success is due.

Since 1907, Doctor Stevens has been particularly interested in the increasingly important question of social hygiene, probably by reasons of its relationship to his dermatological work. Many years ago he organized in Detroit the "Social Hygiene Society," composed originally of physicians, clergymen, and laymen but with the later wise ruling that only physicians should lecture under its auspices. The functions of this organization were notably effective, especially under his presidency, at a day when public opinion on this subject was lethargic and corporate action difficult to obtain. As Secretary of the Detroit Practitioners' Society and as Chairman of the Sanitation Committee of the Board of Commerce, his public spirit and medical acumen were later again revealed in a regulation to control promiscuous public expectoration and to rectify the system of garbage disposal.

* * * * *

In spite of these contrastive interests, which exert a magnetic effect upon his enthusiastic and conscientious nature as well as a momentous drain upon his time and energy, Rollin Stevens is an earnest devotee to mental and physical relaxation. Wisely he seems to prefer the recreative advantages obtained from more gentle pastimes and less strenuous sport to the possible over-exertion of the links or of kindred exercise with but superficial purpose. Yet, because of his love for children and theirs for him, he is ever ready to join with spirit in their festivities out-of-doors or in—whether it be an Indian dance around a picnic bonfire or reading aloud from a storybook. It is the hemoglobin of human love that brightly colors his blood and dispels all physical effect of the passing years, as they seem silently to arrive and to depart in the diaphanous garb of unreality.

Doctor Stevens' real respite from toil, however, is his wholesome absorption in his several avocations, chief of which are mycology and conchology. He makes periodic field excursions in search of mushrooms and expeditions after rare molluscs, sources of never-ending delight that only the true collector can know. Not only was he for years the President of the Detroit Mycological Society, but he has a national reputation as a mycologist. One of the several varieties of mushroom he has discovered has been officially named for him—*Helvella stevensii*. In 1934, as a note of warning to unsophisticated collectors, he (with Mr. Wendell Holmes) described in the periodical *Hygeia* the natural characteristics of a peculiarly poisonous variety, the *Amanita*.

The buoyancy of Stevens' philosophy of life is the probable reason why even those who see him infrequently observe so little physical change in him, even less is noted by his closer friends. "To-day, at seventy," writes one of his intimate associates,⁵ "he hardly seems to have changed since the time I first met him fourteen years ago. His posture, his features, his reactions have altered him but very little. He works as hard and as many hours as ever."

The copious career of Rollin Stevens, observed by his friends as from their task they turn their eyes his way—perhaps for the reassurance of high example—reveals how industriously, how studiously, how productively, and withal how joyously, the age of seventy years may be approached and reached.¹

⁵ Dr. Hans A. Jarre, *Personal Communication*.

BIBLIOGRAPHY OF DOCTOR STEVENS

- 1903 Notes from the Finsen Light Institute at Copenhagen. *The Medical Counselor* (Detroit) 1903 22, 49
- 1903 The Finsen Light. *North American Journal of Homoeopathy* October 1903
- 1904 The Finsen Light Treatment. *New York Medical Journal (Phila. Medical Journal)* 1904 80, 344
- 1904 Cancer from the Sanitary Point of View. *The Medical Counselor* (Detroit), September 1904
- 1904 Therapeutics of Cancer. *North American Journal of Homoeopathy* 1904 19, 753
- 1905 Eczema—Its Pathology and Newer Methods of Treatment. *Cleveland Medical and Surgical Reporter* January–February 1905
- 1905 The Finsen Light in Diseases of the Eye, Ear, Nose and Throat. *Homoeopathic Eye, Ear and Throat Journal*, 1905 11, 457
- 1905 Further Clinical Experience with Radium, with Especial Reference to Lieber's Radium Coatings. *North American Journal of Homoeopathy*, 1905, 53, 720
- 1905 The Roentgen Ray and Finsen Light in the Treatment of Malignant Diseases of the Skin. *Progress*, 1905 (no volume or month indicated)
- 1907 A Preliminary Report of My Experience with Opsomic Therapy of Certain Skin Diseases. *Medical Century* 1907, 15, 69
- 1907 Large Flat Pustulocutaneous and Pustular Ulcerative Syphiloderm. *Medical Century* (New York and Chicago) 1907, 15, 73
- 1907 Eight Months' Experience in the Treatment of Some Skin and Infectious Diseases by Opsogens. *New England Medical Gazette* 1907, 42, 367, *Clinique* (Chicago), 1907, 28, 519
- 1909 Bacterial Inoculations in Skin Diseases. *New England Medical Gazette* 1909 44, 14
- 1909 Preventable Ignorance and the Social Evil. *Cleveland Medical and Surgical Reporter* July 1909
- 1909 X-ray Work in Hospitals. *International Hospital Record*, October 1909
- 1909 Isotonic Sea water in Therapeutics. *Cleveland Medical and Surgical Reporter* 1909–10 18, 71
- 1910 Roentgen Therapeutics. Personal Experiences. *Jour. Am. Institute of Homoeopathy* 1910–11, 3, 625
- 1912 Isotonic Sea water in Therapeutics. *Buffalo Medical Jour* 1912–13 63, 369
- 1913 Further Remarks on Isotonic Sea water in Therapeutics. *Buffalo Medical Jour* 1913, 69, 211
- 1914 Progress in Radiotherapy, with an Account of the Author's Successes and Failures in the Use of Light Radium and the Roentgen Ray. *Detroit Med Jour* 1914, 14, 1
- 1916 A New Timer for Roentgenotherapy. *Am Jour Roentgenol*, 1916 3, 258
- 1916 A Hospital Technique for the Treatment of Cancer. *The Grace Hospital Bulletin*, 1916–17 1, 3
- 1917 The Blood in Cancer under Roentgenotherapy. *Am Jour Roentgenol*, 1917 4, 215
- 1917 A Case of Syphilis with Extensive Gummatous Involvement of the Bones of the Cranium. *The Grace Hospital Bulletin* 1917–18, 2, 12
- 1917 A Case of Keloid of Unusual Extent. *The Grace Hospital Bulletin* 1917–18 2, 15
- 1919 A Plea for Greater Co-operation between the Surgeon and Radiotherapist in the Treatment of Malignant Diseases. *The Leucocyte* 1919 26, No 8 p 7
- 1919 Cancer Therapy. *Urological and Cutaneous Review* 1919, 23, 377
- 1919 The Role of Radiotherapy in Cancer. *The Grace Hospital Bulletin* 1919–20 4, 39
- 1920 The Efficient Dosage in Deep Roentgen Therapy. *Jour. Michigan Medical Society*, 1920 19, 225
- 1921 The Making of an X-ray Diagnosis. *The Grace Hospital Bulletin* 1921 5, 25
- 1921 Some Points on Radiotherapy in Deep seated Cancer. *Journal of Radiology* 1921 2, 21
- 1921 The Treatment of Nævi. *Journal of Radiology*, 1921 2, 33
- 1922 The Radiological Treatment of Superficial Cancer. *Urological and Cutaneous Review* 1922 26, 34
- 1922 James G. Van Zwaluwenburg—a Memorial. *Journal of Radiology* 1922 3, 73
- 1923 Advances in Radiation Therapy of Deep-seated Tumors. *Jour. Michigan State Medical Society* 1923 22, 124

- 1923 Treatment of Cancer of the Breast by Deep Radiation and Surgery, A Rational Method According to Present day Knowledge (with H A Jarre) *Radiology*, 1923, 1, 17
- 1924 Malignant Growths of the Paranasal Sinuses Treated by Irradiation, Electro-coagulation and Other Methods *Am Jour Roentgenol and Rad Ther*, 1924, 11, 532
- 1924 Facts and Theories in Cancer Therapy *Radiology*, 1924, 3, 286
- 1925 Fractures and Their Roentgenological Interpretation *International Jour Surgery*, 1925 38, 11
- 1926 The Use of Intravenous Injections of Radium Chloride in Some of the Malignant Lymphomata *Am Jour Roentgenol and Rad Ther*, 1926, 16, 155
- 1927 Methods of Radiation Therapy in Dermatology *Radiology*, 1927 9, 269
- 1929 Introduction to a paper presented on "The Cinex Camera" by Dr H A Jarre *The Grace Hospital Bulletin* 1929, 13, 1
- 1930 Comments on Radium Technique *Am Jour Roentgenol and Rad Ther* 1930, 23, 197
- 1930 Radiotherapy in Dermatology *Ill Med Jour*, 1930, 57, 336
- 1931 Skin Malignancy, Comments on Therapy *Radiology*, 1931, 16, 435
- 1931 Cancer Institutes (editorial) *Radiology*, 1931, 17, 583
- 1931 The Rôle of the American College of Radiology in Medicine *Radiology*, 1931, 17, 586
- 1932 Treatment of Radiation Injuries of the Skin *Radiology*, 1932, 19, 345
- 1932 Aiding Research in Radiology *Am Jour Roentgenol and Rad Ther*, 1932, 28, 813
- 1934 Beware the Amanita! An Innocent-looking Mushroom—but a Villain in Disguise (with W Holmes) *Hygeia*, 1934, 12, 435
- 1934 Bronchial Obstruction Its Diagnosis and Treatment *Radiology* 1934 22, 339
- 1935 Retardation of Bone-growth Following Roentgen irradiation of an Extensive Nevo-carcinoma of the Skin in an Infant Four Months of Age *Radiology* 1935 25, 538
- 1936 Bundy Allen 1885-1935 (A Memorial) *Am Jour Roentgenol and Rad Ther*, 1936, 35, 268
- 1936 Treatment of Some Infections by Means of the Roentgen Ray *Radiology* 1936 26, 465
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THE RÔLE OF RADIOLOGY IN MEDICINE¹

By GÖSTA FORSSELL, M D , *Stockholm, Sweden*

THE International Radiological Congresses have made it a rule to place on their programs, in addition to the scientific questions, radiological-organization problems of general interest for medicine as a whole. The present Congress has placed on its program for discussion that most central of all radiological-organization problems *the integration of radiology into medicine as a whole*.

The President of this congress, Dr Arthur Christie, and Dr William Mayo, America's world-renowned surgeon, ruler of one of the metropolises in the realm of medicine, have displayed for us their broad view of one side of the problem *the unity of medicine*. To me has been given the honorable task of opening the discussion of the problem's other side *the rôle of radiology as a member of the unity of medicine*.

For the one who can remember the birth of radiology, the story of the development of this science is a marvelous one. The new light became visible like a dazzling meteor in the evening of the nineteenth century. It surrounded the morning of our own century with the rosy light of hope and promise. Like a glittering sun it shines resplendent on the working day of the twentieth century, revealing new fairways and fresh horizons in nearly every land in the world of science.

In medicine, radiology has played the rôle of a *pioneer* and a *creator* in the spheres of diagnostics and of therapy.

Its revolutionizing work in the *domain of diagnostics* is that it has extended the physician's field of vision to include the interior of the living man. Roentgen diagnostic methods have increased diagnostic skill in almost every branch of the medical science, and in this way have contributed in a high degree to the reliability

of our judgment of the indications of treatment and have thereby improved the results of treatment. I will merely remind my hearers that roentgen diagnostics have contributed most essentially to the magnificent progress made during the present century in the provinces of abdominal, thoracic, and cerebral surgery, and in orthopedics. As regards internal medicine, too, roentgen diagnostics have become an indispensable guiding star.

Also radiotherapy, that is, Finsen-, Roentgen-, and Curie-therapy, has created an epoch in the history of medicine. By its destructive action on malignant tumors and dermatic fungi, by its power of hastening or causing a healing process in inflammatory conditions of various kinds, and by its readjustive action on certain disturbances in the functions of the endocrine glands and the hematopoietic organs, radiotherapy has become an indispensable weapon in the service of medicine.

But how is it that radiology has come to play such a rôle that one is entitled to say it has set its seal most decisively on the medical science of the present century? And how, in the future, will radiology be able to continue to play this important part?

All development in living Nature has arisen by means of progressive subdivision of labor and by the differentiation of special organs for special tasks, to which must be added, co-operation between these organs.

New tasks demand the differentiation of new working organs, and awaken to life new forms of co-operation. This law of the differentiation of special organs, for tasks which are of importance for the entire organism, holds good also in the development of medicine, and, as a matter of fact, has given rise to the differentiation of radiology into a special discipline in medicine.

¹ Opening lecture at the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

This differentiation took place simultaneously with the entrance of radiology into the field of medicine. It was brought about by the necessity of controlling certain parts of radiophysics for certain medical purposes, and of possessing techniques, based on this control, for medical examinations or treatments. These examinations and treatments demanded, in their turn, special training, special equipment, and special premises and, finally, special roentgen departments at our hospitals.

Consequently, during the first few years of this century, radiology played the part of a physical auxiliary science in the service of medicine. At the hospitals, radiologists had the rôle of being physical and technical assistants to the head doctors at the clinics.

The differentiation of radiology into a special branch of practical medicine, equal in rank to the other disciplines of medical science, was brought about by the development of radiology—through the scientific elaboration of the results of its work in the field of medicine—into a medical science which demanded the entire ability of its practitioners.

The next step was that the importance of radiological science in the general training of medical men increased so much that a chair had to be found for it in the medical faculties.

The differentiation of radiology into an independent medical discipline has proceeded on parallel lines, but not always simultaneously, within the organizations which constitute medicine's general staff—the medical faculties—and its army in the field—the institutions where medicine is practised.

The development of the part played by radiology at the hospitals and in the faculties has varied much in different countries, and even in different parts of the same country. This is often the result of external causes especially those originating in a want of financial resources during the critical times in which we now live. Principally, however, the struggle for the rec-

ognition of radiology as an independent member of the unity of medicine has led to victory.

Many actual organization problems exist in every country, however, when it becomes a question of such a practical embodiment of the radiological institutions in the hospitals of to-day as will enable the hospitals to fully utilize the conquests made by radiological science. Nowadays, the actual organization-problems are not caused, in most places, by the external differentiation of radiology. It is necessary, first and foremost, to find a practical organization, corresponding to the internal differentiation which, during the last few decades, has taken place within radiology in consequence of the subdivision of labor and the specializing necessitated by the two main tasks of medical radiology: roentgen diagnostics and radiotherapy.

This internal differentiation has, on the whole, followed the same path of development as that taken by the external differentiation of radiology in relation to the other disciplines in medical science. The specializing of the techniques and the growth of the clientele gave the first impulse to the division of radiology into two branches. The innermost cause of this cleavage of medical radiology is to be looked for, however, in an essential difference which exists in the scientific basis of each branch of radiology.

Although the roentgen rays are the common source of roentgen diagnostics and roentgen therapy, still, in regard to their scientific character and their practical employment, they are as widely different from each other as are histology and heliotherapy. The one employs the optical properties of light in the service of medicine, the other makes use of its biological effects.

Roentgen diagnostics is a branch of anatomy. It is the science of man's normal and pathological structure as it appears in the roentgen picture. *Radiotherapy*, on the other hand, is a branch of physiology. It is the science of the action of the different rays on the organism in conditions of health and sickness.

Roentgen diagnostics and radiotherapy demand different scientific training, and the investigation of each belongs to different spheres of medicine. The conditions necessary for their practical utilization are also very different.

Many co-operating, external circumstances, too, have contributed during the last two decades toward the rise of separate institutions for roentgen diagnostics and radiotherapy. But no factor has been more active in this matter than the conquests made by Roentgen- and Curie-therapy in the domain of malignant tumors. Radiotherapy's task of treating about two-thirds of cancer patients, alone or in co-operation with surgery, has, even from a mere practical point of view, made it impossible for one and the same man to satisfactorily direct both the roentgen diagnostic work and the radiotherapy of a large hospital, if he is not a genius.

At most places, this cleavage process in radiology is still in a latent stage. But at this very moment, there are numerous radiologists who are sinking under the impossible task of endeavoring to maintain roentgen diagnostics and radiotherapy on a level with the development of the sciences. At the same time, at most hospitals, financial, technical, and staffing reasons make it impossible to divide the radiological work between altogether different institutions.

It is only where radiology has most vigorously developed that the diagnostic and therapeutic laboratories of the radiological hospital departments have been able to develop into separate institutions. At most places, however, the two branches still remain under the direction of one and the same radiologist. At a number of large hospitals which have become centers for the treatment of cancer, independent radiotherapeutic clinics have been established in addition to the radiological services. It is only at a few places, however, that the chiefs of the latter have been relieved from therapeutic work, and allowed to devote themselves entirely to roentgen diagnostics.

A complete divorce between roentgen

diagnostics and radiotherapy confers such great advantages, both for research work and instruction, as well as for the utilization of radiology in practical medicine, that I consider one of radiology's highest hopes to be the division, as soon as possible, of the radiological work, at university and other large hospitals, in order to embrace separate and independent roentgen diagnostic and radiotherapeutic departments.

The divorce between roentgen diagnostics and radiotherapy at the large hospitals, together with the increasingly extended demands on radiology made by every branch of medicine, makes actual the question of a further differentiation of each of the two main branches of radiology.

A differentiation within roentgen diagnostics has taken place in consideration of the demand for special knowledge of certain branches of roentgen anatomy, and for special technical skill in roentgen examination of various organ systems.

The central roentgen departments which are overburdened with both therapy and diagnostics, have not infrequently been faced by special tasks for which they have been wanting in both time and staffing. The result, at many places, has been a disruptive transference of roentgen diagnostics to roentgen diagnostic laboratories at the different clinics. Such a transference has been necessary also where the various departments of a hospital have stood apart, and without any convenient interior means of communication with each other.

A concentration of the various branches of roentgen diagnostics to a central roentgen diagnostic institute is, however, a desirability of the utmost importance. If a roentgen diagnostician is relieved entirely of the tasks of therapy, he will then be well able to control and direct the work in all the branches of roentgen anatomy by himself, just as the professor in histology is able to control the whole of his province and its immediate surroundings.

A central institute of diagnostics offers great economic advantages, both in regard to the current working and also in respect to the maintenance of the equipment at an

up-to-date level. It provides all the departments of the hospital with opportunities of keeping themselves *à jour* with the development of roentgen technics and roentgen diagnostics in every sphere of medicine. It offers the physicians, and the other staff members of the roentgen institute, great and all-round experience. Above all, a central roentgen institute constitutes a necessary condition for conveying scientific and all-round instruction in roentgen diagnostics.

A centralization of roentgen diagnostics at a hospital is possible only under certain conditions, however. For instance, there must exist good indoor communication from all the hospital departments to the roentgen diagnostic institute, and the co-operation of the latter with those departments which are to be served by it must be organized in such a way that it will act as if every hospital department was provided with its own roentgen diagnostic section. The director of the roentgen diagnostic department must have at his side a staff of assistants who have been specially trained in the various branches of this science and who have at their disposal the necessary special equipment. Our experience in Sweden shows that there should be one assistant roentgen doctor for every 100 to 150 beds at a general hospital with both clinical and polyclinic departments.

The size of the central institute must be so far restricted, however, that it will not have to work for more than about a thousand beds and the corresponding out-patient departments. If the hospitals are larger, then a number of clinics should be grouped around central roentgen diagnostic institutes.

But even if there be carried out as complete a centralization as possible of the roentgen diagnostic institutes, still there must be smaller roentgen laboratories at each clinic where there can be carried out such roentgen examinations—fluoroscopic, especially—as have to be made in immediate connection with other examinations or with treatments.

Within radiotherapy an interior differ-

entiation has occurred, in respect to the radiotherapist's need of knowledge of the special pathology and clinic of the diseases which he has to treat. As long as the radiologist is not a master of the clinic of the diseases he treats, he must remain a technical assistant of the clinician. But all experience has shown, however, that one and the same physician must possess both technical and clinical skill if the resources of radiotherapy are to be fully utilized and have a possibility of development.

Differentiation in radiotherapy has taken place, either by hospital departments for radiotherapy having been created in connection with certain clinics—surgical, gynecologic, and dermatologic, especially—or else by special sections for the treatment of certain organ systems having been added to general radiotherapeutic clinics. The most usual reason for the creation of special radiotherapeutic departments at hospitals has been the greatly increased demand for radiotherapy in cancer. These radiotherapeutic clinics have led to a considerable development of radiological cancer therapy. By their side there have arisen research institutes for radiophysics, radiobiology, and radiopathology which are of inestimable value for the further development of radiotherapy.

If radiotherapy is to fully utilize the rich possibilities it possesses also within the sphere of internal medicine, it should seem necessary to open, as soon as possible, radiotherapeutic wards at the clinics for internal medicine, or else at the general radiotherapeutic clinics, for the treatment of such diseases where radiotherapy is the main factor in the treatment, but which, in other respects, fall within the sphere of internal medicine.

We know that medical research is the basis of practical medical science. If a country is to utilize the progress made by radiology, it is, first and foremost, necessary to create a staff of teachers of radiology and institutions for research and instruction in radiology at the universities.

But this will not be enough. If the progress made by radiology is to benefit

the whole country, then, in addition, the radiological institutes of the general hospitals must be so organized that they will be able to keep pace with the rapid development of radiology

To find recruits so as to be able to create a body of fully trained roentgen diagnosticians and radiotherapeutists, the leading physicians at the radiological departments of the hospitals must be offered such terms of engagement that they will be able to devote themselves entirely to radiology. They must also be provided with sufficient assistance to prevent their being altogether absorbed by the practical work of their department. They themselves must have rich opportunities for studying the further development of their science. Every leading radiologist who wishes to keep up with the times must, in addition to carrying on his work as a doctor, also play the part of a constructor and organizer, so as to be able to regenerate and rejuvenate his department.

Each general hospital of any great size, then, should be so equipped that, for its town and its district, it can play the part of an annex to university institutions. Without such a parallel organization in the hospitals of a country, the medical schools may be compared to broadcasting senders which have no receivers.

With us, in Sweden, it is the task of the State to provide doctors with their general training. The duty of providing special training and the post-graduate instruction falls, above all, on the authorities who have charge of the practical care of the sick. The radiological departments of the large hospitals must, at one and the same time, be organs for the care of the sick, and post-graduate schools for radiologists. This is as much to the advantage of the patients as to that of the instruction.

Radiology has become more and more specialized and attached by ever firmer bands to the hospitals. Only as a limb of a hospital organization, and in co-operation with the other disciplines, can it be developed to perfection. The radiological departments of the hospitals, then, will

remain the headquarters of radiological work. The development of the technics and the science of radiology will, too, in the future, demand deeper and wider knowledge on the part of the specialists in the sphere of radiology.

On the other hand, the radiological sciences are gaining ever increasing clarity, their technics are becoming simplified, and the instruction is developing in such a way that certain parts of radiology will be a possession of the general practitioner. Nay, the time will probably come when a roentgen outfit will be as necessary a part of a doctor's equipment as a microscope. In the same degree, the demand for radiological specialists and for further research into, and instruction in, radiology will increase.

In Sweden, the organization of the institutions for the training of radiologists, and of the radiological departments at the hospitals, has, on the whole, been carried out in agreement with the principles laid down above.

Regular instruction in radiology is given at the three medical faculties in Sweden. At the Caroline Institute, in Stockholm, the instruction in radiology has, since 1936, been divided between two ordinary professorships, the one, in roentgen diagnostics, and the other in radiotherapy. At Upsala, there is a professorship in the entire subject of medical radiology. At Lund, the medical faculty has applied to the Government to change the lectureship in radiology into one in roentgen diagnostics and, in addition, to found a professorship in radiotherapy.

At all the medical faculties in Sweden, there is given a course of lectures (six weeks), obligatory for medical students, at the commencement of their work at the clinics. Beside this, there is a course of instruction, with practical training (two months), at the close of the medical studies, attendance here being voluntary.

Special training in radiology can be had by serving as assistant doctor in radiological departments for a period of from three to five years, after having previously

acted as assistant doctor for, as a rule, two years at surgical and medical clinics. Practical training in radiology, for such doctors as do not intend to devote themselves to radiology as a specialty, is gained by working as an assistant for from six to twelve months at radiological departments.

Complete radiotherapeutic clinics exist in Sweden, a country of about six million inhabitants, at three hospitals, namely, at the University Hospitals at Stockholm and Lund, and at a large public general hospital in Gothenburg. At these three hospitals, the departments for radiotherapy and for roentgen diagnostics are quite separate from each other, each being in the independent charge of a radiologist.

At the new public, general hospital in Stockholm, now in course of erection, the same division of the radiological work will be carried out. At 41 of the country's other hospitals, there exist undivided radiological departments. Hitherto, the rule has been followed that, when a hospital has grown so large that separate medical and surgical departments have been created, there also has been established an independent radiological department.

At the smaller hospitals, there are only diagnostical roentgen laboratories which are in the charge of doctors who have received a short special training in roentgen diagnosis. Practically speaking, all radiotherapy is referred to and carried out at the hospitals which have independent radiological departments in the charge of radiologists specially trained in radiotherapy. Radiotherapy in cancer is not confined to special cancer hospitals but is practised at the radiotherapeutic clinics or the radiological departments of the hospitals.

The radiologists stationed at the hospitals are at liberty to carry private radiological practice, in addition to their official work, at their departments, and the head physicians at the radiotherapeutic clinics have rooms for private patients at the clinics. As a rule, consequently, a radiologist carries on all his work at his department at the hospital.

By what I have now said, I have endeavored to describe the rôle played by radiology in relationship to other branches of the medical unity, and the ways by which, I consider, this science is to move onward as the representative of light in the domain of medicine. But whatever the rôle played by the different disciplines of medical science in respect to each other, and to the other organs of the community, all those who exercise the work of a physician have, first and foremost, to be the servants of their science and of that community. The strong band uniting the various branches of medicine into a unity is the common task of serving suffering humanity, of attempting to prevent, or to cure, disease.

The whole of our training and all our daily work should be devoted to the carrying out of that common duty, and thereby rendering mutual help to all, and no one, I think, plays that rôle more often than does the radiologist, acting as a servant of his comrades in the unity of medicine.

Therefore it is that the radiologist, if he pursue his call rightly, constitutes a link between the representatives of practical medicine. This rôle of the radiologist finds eloquent expression at the general hospital of to-day by the fact that the radiological institute constitutes the daily meeting place of the heads and the staffs of the various clinics.

The International Congresses of Radiology, too, have proved an important link between nations. I would like to remind my hearers that the First International Congress of Radiology in London, in July, 1925, was the first international scientific congress that assembled after the Great War. Since that date, four congresses have brought together multitudes of radiologists from every country of the globe to co-operate in the work of science.

To conclude, it is my pleasant task to express warm homage and sincere thanks to the radiologists of the United States of America for the important part they have played as engineering technicians and scientific investigators in the development

of radiology I need but mention the names of Caldwell, Francis H Williams, Janeway, Lewis Gregory Cole, Preston Hickey, George Pfahler, James Ewing, and George Holmes, all of whom have contributed to lay the foundations of the science of radiology

I also beg to thank and to congratulate the President, the Secretary General, and the National Committee of the Fifth International Congress of Radiology for the

brilliant part this Congress plays in the line of these international gatherings, both by its scientific program and by its calling us together in such a delightful way to this feast of comrades

I feel convinced that this Congress will bear rich fruit in the field of radiological science, and that history will bear witness that it has most devotedly carried out its task of serving a suffering humanity

CONTRIBUTION TO THE PATHOLOGY AND CLINICAL PICTURE OF RETICULUM-CELL SARCOMA¹

By LARS EDLING, M D , Lund, Sweden

Director of the Radiological Clinic, Lund University

THE affections of the reticulo-endothelial system have long been the object of most lively interest on the part of the pathologists. In recent years, the malignant tumors arising from the reticulo-endothelial tissues, in particular, have attracted the attention also of the radiologists, and it therefore seems to me a suitable subject to bring before this Congress, especially as there are several questions in this connection that are in need of further discussion.

PATHOLOGY

Already, in 1914, Ewing had discerned a species of tumors emanating from the reticulum cells of the lymphatic tissue, and in his text-book he definitely speaks of *reticulum-cell sarcoma* as different from the *lymphocytoma*.

In 1930, Roulet, of Berlin, described in detail, under the name of *retiotheliosarcoma*, a group of tumors arising from the lymphatic tissue in lymph nodes, the epipharynx, the tonsils, and other parts of the upper air passages—growths which are doubtless identical with the above-named reticulum-cell sarcomas of Ewing, but which other earlier investigators generally had not noted as different from other lymphogenic tumors and had classed, therefore, under the general heading of lymphosarcoma. Now, Roulet showed that they do not derive from lymphatic cells, but from the reticulum cells of the lymphatic tissue. On account of their varying histologic characters, Roulet suggested the division of them into three groups, as follows:

(1) The *immature*, or *undifferentiated*, type. The tumor is built up of a uniform syncytium of large, pale, round, and polygonal cells, anastomosing with each other through abundant strands of cytoplasm.

The cells have a large, bulb-shaped nucleus with finely divided chromatin, a distinct nucleolus, and a sparse cytoplasm, often containing numerous droplets of fat. This comparatively rare form is considered by Roulet as the *primary type of retiotheliosarcoma*.

(2) *Mature forms*, characterized by the tendency of the tumor cells to develop fine fibrils which arise within the plasma, but with tumors of a higher degree of maturity are seen to enlase the cells of the syncytium as a wide-branching network. In the early stages this fibrillar network becomes apparent only on staining with silver, but with greater differentiation it can in part assume a collagenic character. In sections, the youngest portions within the syncytium—the centers of proliferation or "*Brutstätten*"—appear as areas more or less entirely free from fibrils.

(3) *Associated or combined forms* are those in which the blastomatous process in the reticulo-endothelium is combined with pathologic proliferation also of other cellular elements, such as a leukemia or lymphogranulomatosis. Thus, Roulet establishes a connection with the investigations of Oberling, in which the latter author, makes a distinction between two main groups of *reticulosos* and *reticulo-endotheliosos*, namely, pure and associated. The latter are combined with proliferation of hematopoietic cell types leading to the simultaneous development of leukemia, lymphogranulomatosis, aleukemic lymphadenosis, or pernicious anemia. Oberling even describes combinations of reticulosis and reticulosarcoma, and characterizes Ewing's sarcoma as a form of reticulosarcoma localized to the bone marrow.

Next to Roulet, important contributions to the histopathology of these tumors have been rendered by Ahlstrom, of Lund. In conformity with Ewing, he has preferred

¹ Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

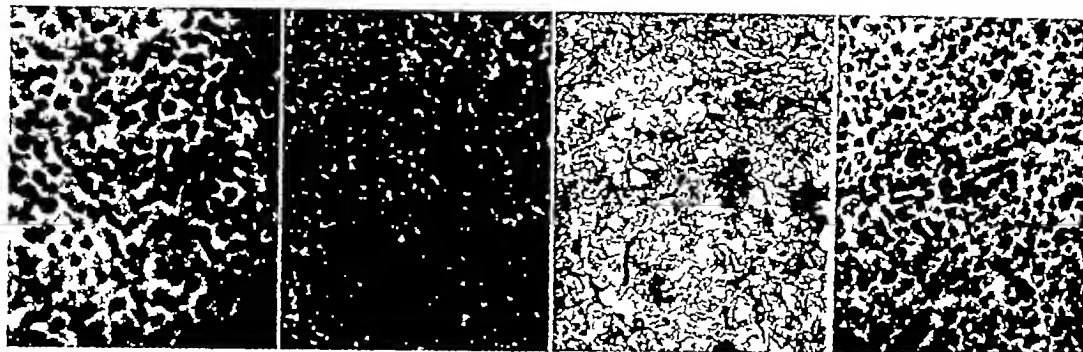


Fig 1

Fig 2

Fig 3

Fig 4

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|-------|---------|--|---|--|
| Fig 1 | Case 1 | Immature type of RCS | Silver staining (Perdrau) | Only very solitary fibrils are seen in the syncytium |
| Fig 2 | Case 6 | Cell syncytium fibrillogenic type of RCS | Hematoxylin (v Gieson) | |
| Fig 3 | Case 4 | Fibrillogenic type of RCS | Fibrillar network with <i>Brulställen</i> | Silver staining (Perdrau) |
| Fig 4 | Case 10 | Polymorphocellular type of RCS, with giant cells | Hematoxylin (v Gieson) | |

the name of *reticulum-cell sarcoma*, because the reticulum cells are not cells overlying a preformed reticulum, but themselves form a cytoplasmic reticulum. In Sweden, therefore, we have generally adopted that appellation (RCS).

Ahlström links up with the works both of Roulet and of Oberling, and he points out that the varying morphology of the cells in RCS can be referred to the inherent possibilities for differentiation of their mother tissue, the normal reticulum cells. The primary type also of these is a simple syncytium, the cells of which have evolved from the primordial mesenchyma, and which therefore are capable of developing in different directions. As supporting tissue for the lymphatic elements they have a tendency to develop a fibrillar reticulum, as active mesenchyma cells they are able to organize themselves as free macrophages, or eventually pass into the blood as monocytes, under pathologic conditions they may change into giant-cells.

Ahlstrom believes that it is not possible to draw a sharp histologic line between the different forms of RCS, but that we must confine ourselves to a classification having in view the *predominant* morphologic characters of the cells. On this basis he sets up, in addition to Roulet's immature and

fibrillogenic types, a third group, *viz*, the *polymorphocellular type*, characterized by extremely varying forms of cells, round, polygonal or highly irregular, often connected with each other by protoplasmic offshoots, so as to form continuous syncytias. Often the cells are developed into phagocytes. Another typical feature is the occurrence of numerous giant-cells with lobed or fragmented nuclei. Differentiation of fibrils susceptible to silver staining occurs, but not as a predominant character of the picture.

The interpretations of Ahlstrom have later (1936) been confirmed by Sjoval, of Lund, who calls attention to the resemblance of the proliferation centers of the growing tumor tissue to the secondary follicles of lymph glands (the reaction centers of Hellman), and points out that the diagnosis of RCS must be ascertained by the appearance of such centers surrounded by an argentophilous fibrillary network, and further through the demonstration of fatty substance in the syncytium cells, both necessary features in the picture of RCS.

Of other works from the last few years, in which RCS is dealt with from the pathological point of view, I will in this connection mention only De Oliveira's compilation of

20 thoroughly studied postmortem cases from Roessle's institute. He concurs in the main with Roulet and Ahlstrom, but has tried to carry the classification still further, and sets up six different groups, though without strictly drawn limits. Of these groups, his No. 6 is especially noteworthy, because it represents a very uncommon differentiation of the reticulum cells, namely, to lymphocytic elements and plasma cells. This is an interesting confirmation of the belief already expressed by Oberling, that the reticulum cells ought to possess just such a prospective tendency to differentiation also in a hematopoietic direction.

My own material consists of 18 cases of RCS, 17 of which are pure, and one associated (namely, with lymphatic leukemia). To these, I have in the following observations added two cases of generalized reticulosis which present certain points of interest. All cases were verified by biopsy, six of them, in addition, by examination postmortem. Cases 1 and 2 arose from the nasal and maxillary cavities, respectively, Cases 3-6 were epipharynx tumors, Cases 7-12 tumors of the tonsils, Case 13 arose from the hypopharynx, Cases 14-18 may be considered as primary lymphoglandular tumors.

Histologically, Case 1 must probably be classed as belonging to the immature type, or at least it is closely related to it. The majority (nine cases) belong to the fibrillogenic and three to the polymorphocellular group. In three cases material for an exact classification is lacking.

For details of the structure, I wish here to refer to the following reproductions of my photomicrographs which I think will demonstrate, better than any description, the characteristic features of the respective types of tumor.

The diagnosis of RCS must, of course, be based on microscopy. According to Bauermann-Schenker, it should be relatively easy to distinguish an RCS from other sarcomas occurring in the upper air passages, such as lymphocytoma,² round-cell

sarcoma, etc. Therefore, I will not dwell on this side of the question, but will confine myself to some words about the relation of RCS to a couple of other tumor groups, where discussion seems to be called for.

This is, first of all, in regard to the so-called *lympho-epithelioma*, described first by Schminke and Regaud. According to Schminke, they ought to be considered as branchiogenous tumors, built up of an *epithelial* syncytium, the cells of which are reticularly arranged and are more or less interspersed with lymphocytes which are considered to form an integrant part of the tumor's structure and to vegetate in symbiosis with the epithelium. In the periphery there is an abundant fibrillar network, which, however, does not penetrate into the actual neoplastic syncytium. Schminke calls attention to the fact that the resemblance to a sarcoma is great in the early stages. By Regaud and his pupils these tumors are considered as belonging to the carcinomas, also Roulet mentions them as a special type of tumor, under the name of *lymphocarcinomas*.

In Lund we have, since the appearance of Schminke's publication, been looking eagerly forward to a chance of diagnosing a lympho-epithelioma, but so far we have not met with any case of that kind. On the other hand, we have observed a considerable number of RCS, of which my material from the radiological clinic forms a part. We have begun, therefore, to suspect that many of the tumor cases described as lympho-epitheliomas have in reality been RCS. We base that belief on the following reasons.

To begin with the *histological* view of the question, Schminke and Regaud have, as before mentioned, adopted the theory of Jolly and Mollier, that the lining epithelium of epipharynx, the tonsils, and the basal parts of the tongue has been modified by symbiosis with the lymphocytes and, therefore, is to be regarded as a special organ, the *lympho-epithelium*, which, according to

because it seems to me to define the nature of this growth more accurately than the name of lymphosarcoma commonly used

² I have adopted the term proposed by Ewing

Jovin, forms the origin of lympho-epithelioma. Ewing, for his part, seems to accept this standpoint to a certain extent, and admits that the lining epithelium is peculiar in structure, whence it would seem reasonable that the tumors arising from it should have special qualities. On the other hand, he emphasizes the great difficulties of discerning lympho-epithelioma from the tumors arising from transitional epithelium.

For a correct interpretation of the tumors in question, it seems to me necessary to consider the general function of lymphatic tissue and its relations to the epithelium. For instance, the lining tonsillar epithelium of the new-born, according to Hellman, whose works on lymphatic tissue enjoy general esteem, holds but solitary lymphocytes, but by the age of one and one-half years they have become very abundant and remain so until puberty, after which time they soon vanish more or less completely, in parallel with the proceeding involution of the tonsil. Hellman holds forth that this interspersation with lymphocytes must be regarded as a link in the chain of protective actions against bacteria performed by the lymphatic tissue everywhere in the body and that the intimate symbiosis between lymphocytes and epithelium presumed by Jolly and others is only hypothetical.

Strong supportive evidence for this opinion is supplied by the conditions in the intestinal wall. As well in the intestinal epithelium as in the submucosa there are, under ordinary circumstances, lymphocytes in great quantities, but these will disappear when the fecal contents of the bowel are freed from bacteria. This is shown by Glimstedt in guinea-pigs bred with completely sterile food: the lymphocytes are then entirely lacking in the intestinal wall. As far as I can see, there exist no reasons why this cell infiltration should have another purpose when occurring in tumors arising from lymphatic regions.

The histologic structures of an RCS and a lympho-epithelioma can without any doubt resemble each other very closely. It ought probably to be extremely difficult, micro-

scopically, to distinguish whether a cell syncytium, growing in such a topographical environment, is of an epithelial or a sarcomatous kind. At least this difficulty will remain until the differential diagnosis has been supported by a difference in the type of cellular nuclei or by the tendency of forming an intraplasmatic fibrillar network. (As to the differential diagnosis against transitional cell carcinoma, see later in this paper.) At all events, the many morphologic varieties characterizing these tumor species must be considered.

I have tried to show why I think the theory of a specific lympho-epithelium cannot very well be maintained. I have examined my material with regard to the presence of lymphocytes, and have found that in three cases they are present in very large quantities in all parts of the tumors, in seven cases they are numerous about the vessels and in peripheral streaks of connective tissue, but comparatively sparse in the cell syncytium proper. In six other cases the interspersation is very scant, except in the peripheral connective tissue. To the last group belongs my Case 1, characterized above as probably immature. In this respect there will thus be found great variations in RCS.

As an argument for the specificity of lympho-epithelioma, some authors (Regaud, Hoffmann, v. Zalka) lay stress upon the fact that lymphocytes form an integral part also of the metastases. For my part, I should think that their rôle in the metastases ought to be the same as I have above maintained regarding the primary tumors. At present, I cannot tell to what extent lymphocytic elements may enter into the composition of metastases from RCS (to alymphatic organs), but I presume that this will depend on the presence of infection. In my Cases 14, 16, and 18, in which such metastases were examined histologically after death, we found no lymphocytes worth mentioning.

Further, the epithelial origin of lympho-epitheliomas has been argued on account of their occurrence also in the thymus, which is considered as an essentially epi-

thelial organ. Now, the thymus is, from a biological standpoint, quite different from the tonsils and the lymph glands, and its "lymphatic" tissue has another structure than these organs, so far as it lacks reaction centers. Probably, its function also is different. As to the histologic nature of the growths of the thymus, the views of different authors stand in marked opposition to one another. Perhaps the existence of lympho-epitheliomas of the thymus, therefore, ought to be subject to further research.

However, the most important difference between the histologic pictures of lympho-epithelioma and RCS is said to be the entire absence of intraplasmatic fibrils in the syncytium of the former (v. Zalka, Jovin, and others). As to this, we must remember that also the immature forms of RCS, such as described by Roulet, Ahlstrom, and De Oliveira and as to a certain extent represented also by my Case 1, more or less completely lack fibrillar differentiation. In a certain number of cases, therefore, it is doubtful whether the lympho-epitheliomas are in reality identical with immature forms of RCS. Considering the diagnostic difficulties against transitional cell carcinoma (Ewing), one might justly suppose that in other cases this tumor species has been falsely diagnosed as lympho-epithelioma.

Clinically, the RCS in most respects seems to answer very well the descriptions of lympho-epithelioma. Both the localization and the general manner of growth of the primary tumor, as well as the pictures published (for instance, those reproduced by Berven in his work on the tonsillar tumors), show a strong resemblance to the characters of our RCS. The early formation of metastases with their markedly mesodermal character (see below), and the very pronounced tendency to generalization, are common for both. Hoffmann admits that the differential diagnosis of lympho-epithelioma, clinically, is uncommonly difficult. On the other hand, some authors (Ewing, Jovin, personal statements) have maintained that lympho-

epithelioma as a rule grows more slowly and often becomes first manifest a long time after the regional metastases have appeared. These tumors may remain small and well defined for months, whereas the RCS tumors are said to have a more pronounced tendency to infiltration. Such small tumors may be completely removed and show an epithelial structure. For my part, I must remark that we have never observed any such cases in our material as could deserve the name of lympho-epithelioma, but there have been some few that most assuredly have been transitional-cell carcinoma.

Finally, the two tumor species resemble each other also in their very noticeable, intense radiosensitivity, in which respect the so-called lympho-epitheliomas differ also from the ordinary carcinomas of the pavement-epithelium type.

In the course of my investigations, I have received some support for my views also from the pathologists and clinicians of the Radiumhemmet in Stockholm. The earliest cases of lympho-epithelioma in the material of that institution were diagnosed histologically by Albertini, of Zurich, and in the beginning the guiding lines for the diagnosis thus established were followed at the Radiumhemmet. I here reproduce (Fig. 6) a photomicrograph of such a case which is included in Berven's material and has been placed at my disposal by the courtesy of the pathologist, Dr. Reuterwall. As the works of Roulet and Ahlström became known, however, both this and other cases of lympho-epithelioma were, on subsequent scrutiny, transferred by Reuterwall to the group of RCS. As a matter of fact, the illustration reproduced shows on many points a great resemblance to the following photomicrograph (Fig. 7) representing a section from my Case 13.

Another group of tumors in the upper air passages that can easily be confused with RCS are the *transitional-cell carcinomas*, first described by Quick and Cutler. With regard to the diagnosis of these tumors, Schunz and Baumann-Schenker, in their article published in 1936, have satisfactorily made clear both their pathogene-

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Further, the epithelial origin of lympho-epitheliomas has been argued on account of their occurrence also in the thymus, which is considered as an essentially epi-

roundly 11.5 per cent. Also, the statements of other authors indicate that they are of that relative frequency. Baumann-Schenker, of Zurich, who has a material of 60 cases of sarcoma of the upper air passages, finds among these six cases of RCS (10 per cent). The patho-anatomical material from the years 1933-1936, investigated by De Oliveira, contains no less than 20 cases. Eigler and Koch, of the Ear Hospital in Halle, observed eight cases during the years 1932-1935, and Gunsett, of Strasbourg, reports 21 cases for the period from 1922 to 1930. In the coming years, the number of cases of RCS reported will probably be very much increased.

Of my material, ten cases are male, eight female. Among the 38 autopsy cases from Roessle's institute mentioned by Roulet and De Oliveira, the female cases preponderate, however, with 57 per cent, as against 43 per cent of male.

The *distribution according to age* shows in my material 11 cases between the ages of 51 and 70, two between 31 and 40, two between 41 and 50, and three over 70 years of age.

It is not easy from such information as is to be gleaned in the literature to get a precise idea of the time which it takes for these tumors to develop. In his first paper on the subject, Roulet thinks he may characterize them as relatively benign, noticeable for their slow growth, and late metastasis formation, but in his second paper he admits that also markedly malignant cases are to be found, especially among the tumors arising from the pharynx. Baumann-Schenker, whose material is too small, however, to make it of any value as basis for such conclusions, is of the opinion that RCS must be regarded as relatively benign. Eigler and Koch, on the other hand, lay stress on the markedly malignant character of their cases, and also Gunsett's material, as well as the case histories of the postmortem cases published by De Oliveira, seem to confirm that view.

My own material seems to me to show beyond doubt that the majority of RCS must be considered as being of a character

extremely malignant, especially on account of their marked tendency to early metastasis formation. All my cases except four had manifest metastases when admitted to the hospital, most of them strongly developed. Table I shows the time elapsed in the different cases between the appearance of the first tumor symptoms, as stated by the patients, and their entrance into the hospital. It shows that three of them—Cases 4, 7, and 14—first noticed glands in the neck a month before their admission. When they were seen on entry, these had already grown into enormous glandular masses occupying the whole extent of the neck. In nine cases—Cases 1, 2, 3, 5, 6, 8, 9, 11, and 12—the history begins with the direct symptoms from the primary tumor in the nose or fauces. Of these, four were admitted within two months or less, two, within three months, and three, within four or five months. Case

TABLE I—FIRST SYMPTOMS AND DURATION OF HISTORY BEFORE ADMISSION

Case	Tumors of Nasal Cavity and Epipharynx	Time	Case	Tonsillar and Pharyngeal Tumors	Time	Case	Tumors of Lymph Nodes	Time
1	Obstruction of nose, bleeding	1 month	7	Cervical node	1 month	14	Unilateral cervical nodes	1 month
2	Headache, mucous secretion	3 weeks	8	Swallowing troubles	2 months	15	Bilateral cervical nodes	3 months
3	Obstruction of nose	5 months	9	Swallowing troubles	3 months	16	Unilateral cervical nodes	6 months
4	Cervical node	1 month	10	Cervical nodes	4 months	17	Unilateral cervical nodes	4 months
5	Obstruction of nose	4 months	11	Obstruction of nose	3 months	18	Unilateral cervical nodes	3 months
6	Swallowing troubles	4 months	12	Swallowing troubles	6 weeks			
			13	Hoarseness	11 months			

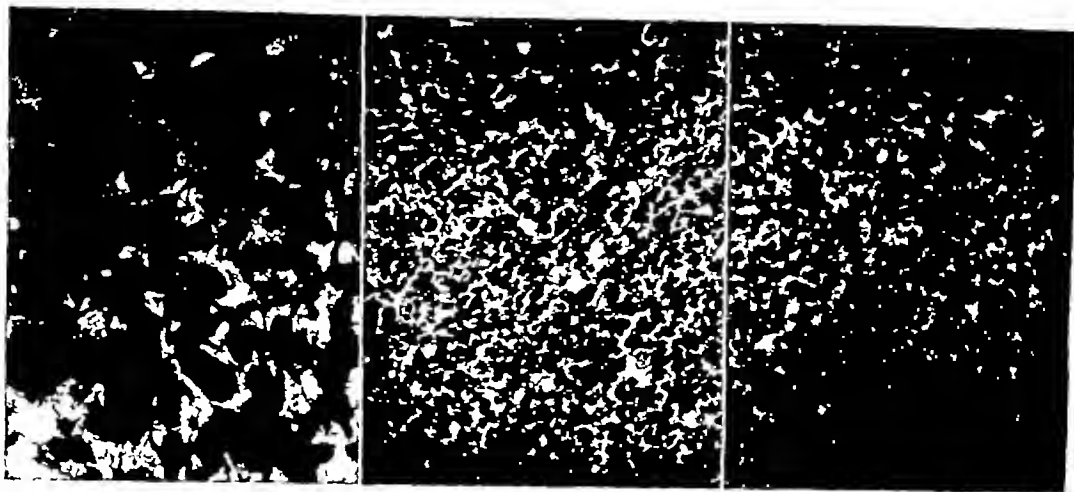


Fig 5

Fig 6

Fig 7

- Fig 5 Case 10 Polymorphocellular type of RCS Silver staining (Perdrau)
 Fig 6 Case classed as lympho-epithelioma at the Radiumhemmet but afterward transferred into the group of RCS
 Fig 7 Case 13 RCS of fibrillogenic type Note close resemblance to Figure 6

sis and their manner of growth. Ewing, however, seems to be the one who has devoted most labor to this research. As before mentioned, he especially states the difficulties in distinguishing them from lympho-epithelioma. According to our experience in Lund, several tumors of this kind may also present, in different parts, a great resemblance to RCS, the arrangement of their cell tissue often being confused or even reminding one of a syncytium. However, in the majority of cases there will probably, at least in some places, be found the alveolar disposition of the cells generally characterizing a carcinoma. Further, their nuclei have another aspect and lastly, these cancers lack the fibrillary differentiation characteristic to most RCS.

Clinically, one finds many characters strongly reminding one of an RCS. The outer shape of the primary tumor is, though, usually not so voluminous as in the latter, but more flattened, and very unlike that of the pavement-epithelium cancer. The early metastases which sometimes are manifest even months before there is any demonstrable sign of primary tumor, the rather marked tendency to generalization, and the considerable radiosensitivity—all

these are characters that may also be found in RCS.

In Lund, we have, during the period 1930-1936, had 12 cases of transitional-cell carcinoma, or, as we used to call it in Sweden, undifferentiated cancer, of the nasal cavity, the epipharynx, and the fauces. Only one of them has, in an early stage of its course, been transferred to the group of RCS, it figures as Case 1 in my material. In a couple of other cases the histologic diagnosis presented some difficulties, but their identity as cancers could nevertheless be established. As in Quick's and Cutler's material, the morphology in this group of tumors varied considerably. We have seen cases with uniformly rounded or oval cells, growing either in typical alveolar formations or more diffusely infiltrating, and others with a pronounced cellular polymorphism and an irregular manner of growth.

CLINICAL CHARACTERS OF RCS

Occurrence and Development—The RCS are no uncommon tumors. Of our entire material of malignant tumors of the throat and lymphatic organs in the years 1929-1936, 150 cases in all, they constitute

by excrescences and often coated with gangrenous necroses. In contrast to the RCS, the lymphosarcomas seem long to retain the form of the tonsil, and to have a smoother surface. Also, their ulcerations are less deep, and have rather the character of superficial, gray-coated mucosal defects (Berven).

Primary Lymph Node Tumors—The five cases of these which I have observed were all localized to the lymph glands of the neck. With regard to the localization of RCS, in general, Roulet notes that they seem to have a certain predilection for the upper part of the body. His material, at the time when he made this observation, consisted exclusively of lymphoglandular tumors, only one of which was situated as far down as the groin. His opinion is fully confirmed by later publications, in which the great majority of tumors, just as in my own material, are seen to have originated in the upper air passages, whereby that predilection finds its natural explanation. Clinically, I have not been able to see any marked difference between the RCS primarily occurring in the lymph glands, and the regional lymph gland metastases.

The *metastases*, in the case of these tumors, occur as well along the lymph vessels as along the blood vessels. In the case of tumors of the pharyngeal cavity, the regional metastases often develop so early that their enlargement is the first clinical symptom noticed. In the very early stages, these glandular metastases are very little characteristic and are difficult to distinguish from tuberculous lymphomas or lymphogranulomatoses. In cases of slow development the glands may remain thus for a rather considerable time, solitary or multiple, displaceable and of limited size. In the majority of cases, however, the growth is very rapid, the process attacks the neighboring glands and infiltrates the surrounding tissues, reactive edemas develop, so that within a few weeks large concreted masses are formed, in which the palpating finger is no longer able to distinguish the individual nodes. In not a few cases there is an almost simultaneous de-

velopment of bilateral glandular metastases, even though the primary tumor in the fauces is decidedly unilateral, and often the tumor spreads in a short time even to the axillary glands, which then readily attain the same size as the glands of the neck, or even larger. As long as the process of infiltration has not advanced too far, the consistency of the metastases is fairly solid, but not so hard as is usually the case in cancer. On the whole, the metastases in the case of RCS bear the definite mark of the mesodermal origin of the tumor.

Another marked characteristic of the RCS is their pronounced tendency to become *generalized*. This has been noted by all previous authors, and could in my material be demonstrated in five of the cases in which an autopsy postmortem was performed (Cases 2, 14, 15, 16, and 18). What particularly stamps the course of an RCS, clinically, as something fateful, is that such distant metastases not infrequently occur secondarily, long or shortly after the patient has been happily freed both of the primary tumor and any existing regional metastases, and without any recurrence having set in at the sites thus treated.

In the following I have attempted to sort out *different clinical types* of metastases from my material. The largest number of cases, namely, Cases 3, 4, 5, 7, 10, 11, and 15, show—so far as it has been possible to trace—metastases only to regional and distant groups of lymph glands. In five cases, namely, Cases 13, 14, 16, 17, and 18, metastases occurred first in regional and distant glands, in a later stage also in internal organs. Cases 1, 2, and 6 are characterized by metastases to the skin and subcutaneous tissues, and in Cases 1, 2, and 13 there are numerous metastases to the skeleton, of a purely destructive type.

With regard to the origin of the *tumors in lymph glands*, Ahlström says that usually it is not a single gland alone that undergoes a blastomatous transformation, but that the process begins in several nodes at the same time. This should be due to a multicentric genesis of the RCS—a tendency to



Fig 8 Case 2 (above) Bone metastases of RCS in the scapula and humerus

Fig 9 Case 1 (below) Bone metastasis in the femur (a) before and (b) after roentgen treatment

developed with lightning rapidity in the course of a few weeks. Making allowance for the negligence with which many persons treat their symptoms when there are no pains, these facts seem to indicate a very rapid evolution. On the other hand, there are cases, though more rarely, in which the progression is slow. In Case 13, for instance, eleven months intervened between the occurrence of the first glandular metastases and the patient's admission, but in the meantime he had several times been treated with roentgen rays in another hospital, so that the present tumor was a recurrence. In Case 16, too, the patient had been going with her tumor for six months before she came to us.

The Gross Appearance of the Tumors —

The appearance of *epipharynx* tumors is only slightly characteristic. They usually form hard, knotty, easily bleeding masses of a more or less reddish color, which often fill the whole epipharynx, hinder the respiration by blocking the choanæ, or cause bleeding through compression of the tubal ostium, and sometimes pain in the ear region.

Primary tumors of the tonsils manifest themselves in the early stages as uniform swellings of the tonsil, whose external shape remains unchanged. The consistency is mostly firm, though softer than in cancer, the mucous lining is usually intact, the surface smooth or finely granulated. The color is usually darker red than that of the surroundings, and generally of a bluish-violet tint. With increasing growth, these tumors become very large and voluminous, block nearly the whole of the mesopharynx, and usually spread as a continuous growth upward into the epipharynx and downward along the lateral wall of the hypopharynx, eventually reaching as far as to the pyriform sinus. A noticeable feature is their tendency to infiltrate the surroundings, the soft palate, the pharyngo-palatine arches, and the root of the tongue, whereby the tumor becomes strongly fixed toward the depth. These large tumors ulcerate very easily, which results in the formation of deep, fissured craters surrounded

14 was admitted with a recurrence following an extirpation of glands, performed in another hospital, and this recurrence had

this technic there is great prospect of obtaining permanent healing both of primary tumors in the fauces and nasal cavity, and of any possibly existing regional metastases

The *protracted roentgen treatment, ad modum* Coutard, which, for instance, in Schinz' institute is employed routinely also for RCS, we have not been able to use because of lacking facilities

On the other hand, we have in two cases used *teleroentgen treatment* (the longest focus distance which we are able to employ in our present x-ray department is 120 cm), either in the form of irradiation of the trunk *in toto* (Case 16, the treatment, only begun, was interrupted by the death of the patient), or with the body marked off into several large portals and serial irradiation *ad modum* Mallet (Case 1) This method seems to give satisfactory results, and may be recommended on probation for suitable cases

In a few cases, *radium* has been employed to complete the treatment In five cases, in which remnants of the tumor remained, we used *telerradium*, but without obtaining any better result than with the roentgen ray In two cases, *local application of radium* was used as a complementary technic with good result in the epipharynx and the tonsillar region A routine combination with local radium application, similar to Berven's technic for sarcoma of the tonsil, we have not deemed necessary, considering the great improvement that may fairly be counted on from the roentgen treatment alone, when carried out according to the fractional dosage technic

The following tables will show the results of our treatment It is evident that there cannot be any question of five-year results, as the material is from the period 1929-1936, and most of the cases have so far been followed up only for a few years As far as RCS is concerned, however, every single case observed is of interest, and I have, therefore, not hesitated to include even a couple which were treated as late as in the beginning of this year

Four cases (4, 9, 11, and 12) remain free

TABLE II—CASES SYMPTOM-FREE

No	Pat	History	Primary Tumor	Metastases	Treatment	Immediate Results	Clinical Course	End results	Duration of life
4	I J woman 61 years	1 month (Dec 6, 1935)	Epipharynx total, P A D, fibrillar type	Bilateral fixed nodes of neck and axilla	Fractional roentgen	Symptom free	No recurrence	Alive symptom free	1 year, 4 months
9	A K, man 33 years	3 months (May 14, 1931)	Left tonsil, P A D, fibrillar type	Diffuse lesion of nodes, left neck	Fractional roentgen	Symptom free	No recurrence	Alive, symptom free	0 months
11	J H man 75 years	3 months (Oct 19 1934)	Left tonsil P A D, fibrillar type	Fixed nodes left neck	Fractional roentgen	Symptom free	Axillary recurrence, treatment, symptom free	Alive symptom free	2 1/2 years
12	J I, man, 70 years	1 1/2 months (Jan 18 1937)	Left tonsil, P A D, fibrillar type	No metastases	Fractional roentgen	Symptom free	No recurrence	Alive symptom free	0 months
6	J N woman, 70 years	4 months (March 24 1936)	Back wall of epipharynx, P A D, fibrillar type	Bilateral cervical nodes movable	Fractional roentgen local radium application	Symptom free	Metastases of subcutis, both arms, treatment	Alive symptom free(?)	1 year 2 months

involve the system by simultaneous attack on parts of tissue belonging to the same functional unit. He would see in this the indication of a possible relation to the generalized reticuloses.

When the generalization of an RCS has once begun, the process may thus attack almost any organ. In my material, metastases have been demonstrated in mediastinal, retroperitoneal, and mesenteric lymph glands, in the liver, spleen, pancreas, and bone marrow, in the mucosa of the digestive tract, in the lung tissue, the renal parenchyma, and the testicles, finally also, in subcutaneous tissues, the musculature, and the skeleton. Histologically, the metastases are everywhere characterized by destruction of the normal tissues, and the substitution of the latter by the typical reticular-cell syncytium.

I have not in my material been able to ascertain *primary blood changes* of any magnitude, except in Case 2, which showed a typical lymphatic leukemia of chronic character, with 428,000 white blood corpuscles, 97 per cent of which were lymphocytes.

THERAPY

It goes without saying that a type of growth with such malignant characters as those of RCS is in every way unsuitable for surgical treatment. The large risks of an operative intervention are illustrated, for instance, by my Case 14, in which large local recurrences developed within a few weeks after extirpation of the primary lymph node tumor. Eigler and Koch, also, report two cases of RCS of the tonsil, in which extirpation was done because carcinoma of the tonsil was suspected (*sic*). In both cases the result was immediate recurrence and the death of the patient. Of course, not even a biopsy should be done unless there is a possibility for subsequent rational treatment.

By *rational treatment* I mean in these cases *radiation treatment*, a therapy indicated specially on account of the great radiosensitivity of these tumors, which has been ascertained by all the authors who

have studied them, and which has also been noticeable in my material. Both the primary growths and the metastases to lymph glands and organs possess this quality, and even on irradiation of bone metastases we have observed a distinct effect in the form of new formation of bone and sclerosis. The radiosensitivity is not so striking, however, as that of lymphocytomas, for instance, and the doses required for producing a clinically noticeable effect on an RCS are markedly higher. Nevertheless, radiation therapy is the only method by which there is at present any prospect of obtaining lasting freedom from symptoms in these tumors, because, if properly employed, it may influence at the same time the primary tumor and the nearest glandular regions. Also, in cases of incipient generalization the irradiation can check the development of the process, at least to a certain extent. On all this, I believe, there is no difference of opinion, but on the other hand, a review of the literature shows that different radiologists have chosen different methods of radiation, and also that in favorable cases a good result may be obtained in different ways.

In the radiologic clinic in Lund I have used, as a principal method, simple fractional roentgen, with a secondary tension of 165–170 kv, 6–7 ma, focus-to-skin distance 40–50 cm. With these factors, and with a filter of 0.5 mm Cu + 1 mm Al, our apparatus gives us, respectively, about 35 and 25 r/min with Thoraues' tin filter, respectively, about 15 and 10 r/min. In the first years, when we were not so familiar with the biological characters of RCS, we gave short series of treatment, with relatively large single doses of the roentgen ray. The results were on all points inferior to what we have obtained later since we began to use a more regularly fractional treatment with smaller daily doses—on the average 150–200 r—and spread the full treatment over at least two and a half or three weeks. The total dose to each portal has varied between 900 and 2,500 r, but should not be less than 1,500 r, divided into eight to ten single doses to each portal. With

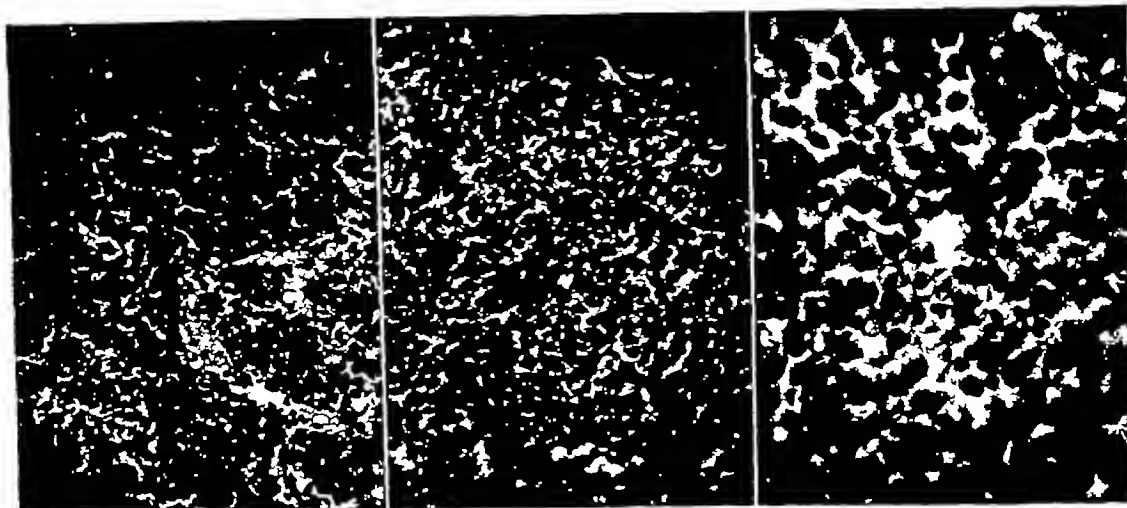


Fig 10

Fig 11

Fig 12

- Fig 10 Case 2 RCS associated with lymphatic leukemia
 Fig 11 Case 20 Generalized reticulosis Section from skin infiltration in the groin
 Fig 12 Case 19 Generalized reticulosis with numerous mitoses (see arrows)

treatment Which one of the two pathologic factors was determining for the final issue it is impossible to decide with any certainty

The results now reported will probably, in the eyes of most observers, seem rather poor, and so they are from a general standpoint However, the results of a therapy are in a high degree dependent on the character of the material In this respect, I wish to call attention to the well-known fact that, in radiotherapy, such tumors as show the most marked radiosensitivity very often will give bad results as to the possibility of permanent cure This proves true also with RCS and depends without doubt on their tendency to form metastases, both regional and distant The results published by other authors (Gunsett, Koch, and Eigler) bear the same stamp of the impending danger of generalization of the process, whereby the expectation awakened by local healing too often is frustrated There seems to be no other help for this difficulty than increased efforts from the organization to make the patients seek assistance as early as possible

At last, some words on the two cases of *generalized reticulosis* above named According to Oberling and Guérin, this diag-

nosis ought to be reserved for cases in which the pathologic process cannot be defined but as proliferative phenomena in the reticulo-endothelial cells that constitute their main histopathologic substratum These demands are altogether answered by both cases, though between them there exist great differences

In Case 19 (female, aged 58 years) the history of development is very short, the malady arising from the axillary nodes and in a few weeks spreading to the other external lymphatic regions The upper air passages were not involved, the liver was enlarged, but not the spleen There was a moderate anemia with a light monocytosis Roentgen treatment had a good immediate effect, but in a very short time a new gland tumor appeared in the epigastrium, and the liver increased Renewed treatment was tried in vain, and in a couple of months the process led to death

Case 20 (female, aged 46 years), on the contrary, has a markedly chronic course Seven years ago the glands of the left groin began to swell, two years later those of the right side also were involved One year ago, there appeared an infiltration of the skin of both inguinal regions in the shape of hard, reddish-brown tumors, rather closely

TABLE III—CASES DEAD DURING FIRST TREATMENT

No	Pat	History	Primary Tumor	Metastases	Treatment	Immediate Results	Clinical Course	End results	Duration of Life
10	P J, man, 67 years	4 months (March 1, 1932)	Both tonsils, preferably right P A D, polymorpho cellular type	Bilateral cervical nodes movable	Roentgen, teloradium, treatment interrupted	Improved	Heart failure	March 23, 1932, broncho pneumonia	3 weeks
15	K P woman 68 years	3 months (July 5, 1933)	Bilateral cervical nodes, P A D, polymorpho cellular type	Mediastinal nodes, Liver	Roentgen, interrupted treatment	Lung embolism		July 6, 1933, lung embolism	1 day
16	B A, woman, 60 years	6 months (Dec 2, 1933)	Cervical nodes, right side, P A D, fibrillar type	External lymph node regions, P A D, fibrillar type	Roentgen, total irradiation interrupted	Not improved, asphyxia	Distant metastases cachexia	Dec 20, 1933 cachexia	3 weeks

from symptoms, having been followed up through, respectively, six, two and one-half, one and one-half years, and six months. Case 6 has shown, after freedom from symptoms for one year, beginning metastases in the subcutis of the arms, which now are being treated. On the whole, the experience with this material shows that in RCS recurrences and metastases usually occur considerably earlier, that is, at the latest, six months after the treatment. There is thus some reason to suppose that the four cases above named will continue to remain free from symptoms.

Three patients died while the treatment was yet in progress, one from pulmonary embolism, one from bronchopneumonia, and one because of distant metastases (Cases 10, 15, and 16).

In four cases death supervened owing to local recurrences or persisting tumor remnants which progressed afresh after treatment. In all these cases the treatment must be said to have been insufficient or the technic employed unsuitable (Cases 3, 7, 8, and 17).

Case 14 was a local recurrence following operation, and its prognosis was particularly bad. The patient died with generalized metastases after a few months. Also, in this case the technic was altogether unsatisfactory.

Cases 1, 5, 13, and 18 died with distant metastases relatively long—7 to 18 months—after the beginning of the treatment. The last three named of these patients (Cases 5, 13, and 18) were at the time of their death still free from both local and regional symptoms. Case 1 shows a curious course, with repeated recurrences and metastases, chiefly to the subcutis, the testicles, the nasal cavity, and the skeleton.

Finally there remains Case 2, which was complicated with lymphatic leukemia, the symptoms of which can perhaps be traced back in the case history for about a year. The course of this case was extremely rapid, the patient dying only one month after beginning of the treatment, though both leukemic and the sarcomatous changes seemed to indicate a strong effect of the

TABLE V—CASES DEAD FROM DISTANT METASTASES WITH PROTRACTED COURSE

No	Pat	History	Primary Tumor	Metastases	Treatment	Immediate Results	Clinical Course	End results	Duration of life
1	B J, man, 63 years	1 month (May 14, 1935)	Left maxillary sinus, nasal cavity, P A D, undifferentiated	No metastases	Fractional roentgen telordium	Symptom free	Metastases to the testis, skeleton subcutis, muscles, local recurrences of nose, treatment, renewed recurrences	*March 8 1937, distant metastases, cachexia	1 year 9 months
5	M P, woman, 59 years	4 months (March 9 1936)	Back wall of epipharynx, P A D, fibrillar type	Bilateral cervical nodes left axillary nodes	Fractional roentgen	Symptom free	Distant abdominal metastases treatment	*Oct 11 1936, general cachexia	7 months
13	J E, man 70 years	11 months (Nov 30 1933)	Left wall of hypopharynx, P A D fibrillar type	Left cervical nodes movable	Fractional roentgen	Symptom free	Distant metastases to lymph nodes colon, skull, protracted course	*Dec 21, 1936, metastases, cachexia	3 years 1 month
18	A J woman 31 years	3 months (Sept 23 1936)	Right cervical nodes, tonsils(?), P A D, fibrillar type	No metastases	Fractional roentgen	Symptom free	Distant metastases, treatment, protracted course	*Nov 5, 1936, cachexia and uremia	14 months

*Signifies that patient died

TABLE VI—CASE ASSOCIATED WITH LEUKEMIA AND TWO CASES OF GENERALIZED RETICULOSIS

No	Pat	History	Primary Tumor	Metastases	Treatment	Immediate Results	Clinical Course	End results	Duration of life
2	J I, man 75 years	3 weeks (Jan 11 1937)	Left nasal cavity P A D fibrillar type lymphatic leukemia (associated)	External lymph node regions	Fractional roentgen	Regression of tumor and leukemic blood changes	Cachexia	*Feb 12 1937 cachexia	1 month
19	M H, woman 58 years	5 weeks (April 20 1935)	Left axillary nodes P A D reticulosis fibrillar type	External lymph node regions	Fractional roentgen	Improved decrease of nodes	Internal and external nodules	*Aug 4 1935 cachexia	3 1/2 months
20	J J woman 46 years	7 years 5 year, 1 year (Feb 15 1937)	Left inguinal nodes, right inguinal nodes, skin lesions P A D reticulosis fibrillar type	Right axillary nodes	Fractional roentgen	Improved regression of nodes and skin lesions	Metastases left cervical nodes treatment	Alive in treatment	6 months

*Signifies that patient died

TABLE IV — CASES DEAD FROM PERSISTING TUMORS OR LOCAL RECURRENCES

No	Pat	History	Primary Tumor	Metastases	Treatment	Immediate Results	Clinical Course	End results	Duration of Life
3	A N, man, 45 years	5 months (Feb 5, 1932)	Right side of epipharynx, P A D, type unknown	Bilateral cervical nodes, movable	Fractional roentgen, teleraidum	Symptom free	Local recurrence not treated, cachexia	*Oct 1932, from local recurrence	8 months
7	J O, man, 57 years	1 month (April 10, 1929)	Both tonsils, preferably right, P A D, type unknown	Fixed nodes right neck and left axilla	Fractional roentgen	Improved not symptom-free	Progression	*July 21 1929, general cachexia	3 months
8	A P, man 50 years	3 months (May 13 1931)	Right tonsil, P A D polymorpho cellular type	Fixed cervical nodes, right side	Fractional roentgen, teleraidum local radium	Not quite symptom free	Local recurrence, treatment, lymph gland dissection	*Feb 9, 1931 distant metastases, cachexia	9 months
14	A S man 37 years	1 month (Dec 18 1929)	Recurrence of cervical nodes (operated on), P A D	Bilateral axillary nodes	Fractional roentgen	Not quite symptom free	Distant metastases, treatment	*Aug 4 1930	8 months
17	P O woman 71 years	4 months (Aug 2 1935)	Cervical nodes left side P A D, type unknown	Cervical nodes right side	Fractional roentgen	Improved	Local recurrence	*Oct 20, 1935, local and distant recurrences	2 1/2 months

* Signifies that patient died

resembling keloids. On admission in February, 1937, the process had spread also to the axillary glands and there was a light anemia. The upper air passages and inner organs were not impaired. A fractional roentgen treatment brought about a nearly complete vanishing of the gland tumors and skin infiltrations, which were replaced by fibrosis. Later on, however, beginning impairment of the general condition, increased anemia, and fresh nodes in the neck showed that the malady was proceeding and had a systemic character.

In both cases, the histologic diagnosis was *reticulosis*. In the literature, I have not found any descriptions of such skin infiltrations as described above in *reticulosis*. In both cases, the reticular syncytium had a typical, uniform aspect with a tendency to formation of an intraplasmatic fibrillar network.

In fact, the clinical prognosis with generalized *reticulosis* seems to be as bad, if not worse, than in generalized RCS. Although the malady may in some cases take a mild and protracted course, anemia and cachexia will gradually predominate. Histologically, also, there are changes suggesting that the limits between these two related conditions often cannot be sharply drawn. Thus, in Case 19, although the character of a uniform reticulo-cellular hyperplasia preponderated, we found rather numerous mitoses and in some places also a very thorough transformation of lymphatic tissue into a reticular syncytium. On the other hand, certain cases of RCS (for instance, my Case 18) have revealed systemic reticulo-cellular formations of such a character that the pathologist has hesitated as to

BASIC PRINCIPLES FOR SUCCESSFUL ROENTGEN THERAPY OF CARCINOMA

By PROF DR HERMANN WINTZ, *Erlangen, Germany*

(TRANSCRIPTION BY H A JARRE, M D, *Detroit Mich*)

THE value of radiotherapy certainly is not disputed any longer, but its execution is very difficult and should be based on thorough knowledge and personal experience. Therefore, it is easy to understand that results are not equally satisfactory in all the clinics where roentgen rays are used. It should be added that those who pass an unfavorable judgment have only a very superficial knowledge of radiotherapy, they usually ignore the physical foundations as well as the biological actions of the rays. The application of roentgen rays is an art to be learned and practised just as the art of surgery. Results will never be favorable in places where a patient, suffering from cancer, is sent to the roentgen room to be treated by a non-medical personnel.

The possession of a modern roentgen machine is not the only or most important prerequisite of successful roentgen therapy, surprising as such a statement might still be to some illogically thinking medical and non-medical persons. Certainly, any surgeon would be offended if somebody would dare to attribute his good results exclusively to his well furnished surgical amphitheater or to his modern instruments. However, the results a roentgen therapist obtains by his treatment are attributed too frequently to nothing other than his modern equipment.

To be sure, the best machines and accessories constructed to-day are none too good for serious roentgen therapeutic efforts, in fact, we still lack machines which operate continually with precision, thus reproducing, without fail, rays of identical characteristics and quantity.

Present-day apparatus cannot be left to work independent of control. Obviously, operators of such machines must be thoroughly aware of their physical and

technical deficiencies. They must also have a sound knowledge of the physics of roentgen rays, for one of the most difficult problems of roentgen therapy is correct dosage.

Though we speak to-day of an international roentgen unit, designated by "r," an outsider only could be of the opinion that the application of this dose, its reproductibility and, last but not least, its exact scientific determination, are simple measures. The statements of many papers, that a certain number of r units has been applied, are useless, if prevailing biological and physical conditions are not recorded correctly—and in detail.

Knowledge of the exact physical characteristics of roentgen therapy is of the same importance as that of the medical and biological characteristics.

I emphasize my conviction that both are equally important, as there are still quite a number of authors who attribute failures to faulty biological reaction of the organism instead of recognizing their own roentgen therapeutic shortcomings. Nature itself, through a different radiosensitivity of body cells, provides the basis for all radiotherapeutic attack on cancer. Here I must dispose of an old error, which, though corrected long ago and often, still reappears in the literature from time to time, regarding the conception of radiosensitivity. *There is no "elective" radiosensitivity.* The assumption of such an electivity has caused some of the most disastrous effects during the past twenty years. Experience has shown that all the cells in the body are affected, and none are immune to destruction by roentgen rays.

The possibility of efficient cancer therapy, therefore, is based upon the fact that cancer cells are more radiosensitive than normal cells. But this postulate should be



RADIOLOGY

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whether he should diagnose a reticulosis or a reticulum-cell sarcoma (RCS)

The more cases of disturbances of the reticulo-endothelial system become known and are described, the stronger is the impression one gets of the numerous varieties and transitions existing between the special types that are published

LITERATURE

- AHLSTRÖM Acta Path Scand, 1933 10
 BAUMANN-SCHENKER Strahlentherapie, 1934, 51
 BAUMANN-SCHENKER and SCHINZ Fortschr a d
 Geb d Röntgenstrahlen 1936 53
 BERVEN Malignant Tumors of the Tonsil Acta
 Radiologica Suppl XI
 CRACIUN and URSU Bull de l'Ass franç pour
 l'étude du cancer 1933, 22
 EIGLER and KOCH Arch f Ohren Nasen- u
 Kehlkopfheilkunde
 EWING Am Jour Roentgenol and Rad Ther
 1929 21 313

- Idem Am Jour Path, 1929 25
 Idem Neoplastic Diseases, second ed 1922
 GUNSETT Bull de l'Ass franç pour l'étude du
 cancer 1930, 19
 HELLMAN Der lymphatische Rachenring Hand
 buch der Mikroskop, Anatomie d Menschen, 1926,
 5
 Idem Untersuchungen über die Funktion des lym
 phatischen Gewebes Kungl Fysiografiska Sällska
 pets i Lund förhandl 1932 1
 Idem Die Einlagerung von Zellen in Schleimhäuten
 und Epithel Anat Anzeiger 1934, 78
 HOFFMANN Der lymphoepitheliale Tumor, Strahlen
 therapie 1932 45
 OBERLING and GUÉRIN Le Sang 1934 8.
 DE OLIVEIRA Virch Arch 1936, 298.
 QUICK and CUTLER Surg, Gynec and Obst 1927
 45
 REGAUD, v REVERCHON and COUTARD Bull et
 Mém de Soc d'Oto-rhino laryngol 1921
 ROULET Virch Arch 1930 277, 1932 286
 SCHITTENHELM Handbuch d Krankheiten d Blutes
 1925
 SCHMINCKE Beitr Path-Anat 1921 68.
 SJÖVALL Acta Path Scand 1933 10
 v ZALKA Ztschr f Krebsforsch 1934, 41
 ZUPPINGER Maligne Pharynx- und Larynx-tumoren
 Fortschr a d Geb d Röntgenstrahlen 1931 40

of roentgen rays, a "caustic dose," one soon can observe severe hyaline degeneration, pyknosis, and keratolysis. The use of such high doses in practical roentgen therapy would be absurd. The highest permissible dose is one just sufficient to inflict lethal injury to quiescent cancer cells. With the employment of such relatively small doses, about three weeks have to elapse usually before a diminution of the tumor can be observed macroscopically. Only cells in the karyokinetic stage have perished immediately after roentgen treatment. The rest of the cells continue to live up to the moment of their karyokinesis. Cells which have been in a state of complete rest at the time of radiation have suffered the least severe injury, they are able to undergo karyokinesis once or twice, but after that, their regenerative function is extinct. If one desires to apply to the action of the roentgen rays on a cancerous tumor one single descriptive term, one might speak of "castration" rather than of "destruction."

The reason for application of the smallest curative dose for the elimination of cancer is the necessity to spare the surrounding tissue as far as this can be done, for, after the dissolution and death of the cancer cells, young bands of connective tissue are to replace the former strands of carcinoma.

The dose necessary for successful treatment of cancer has been determined long ago and has been tested in numerous cases. We have called this quantity of rays "cancer dose" (Ca-D). It has been expressed in physical terms and by establishment of a relationship between electrophysical units and a biological phenomenon. Knowing that the first impressive reaction following application of a certain amount of roentgen radiation is an erythema, we have correlated it to this reaction manifest in the skin. If the dose is increased, desquamation occurs and even caustic destruction. We designate as "skin unit" that quantity of rays which produces a marked reddening of the skin after from eight to ten days, and after from four to six weeks a faint tanning, often

lasting for years. This reaction of the skin is rather constant. There are no material variations between representatives of various races. This "skin unit," as determined electrometrically, includes a biologic variation of ± 10 per cent.

We relate other biological measuring to the "skin unit" in order to form a conception concerning the reaction of individual cells, but, we also record the magnitude of the various doses in the international unit, "r."

The dose necessary for arrest of the menstrual cycle is the "sterilization dose," which amounts to 34 per cent of the "skin unit," it means that about one-third of that single quantity of roentgen rays which is tolerated by the skin without permanent damage is sufficient to destroy the highly radiosensitive cells of the ovarian follicles.

We have found the "cancer dose" to be from 90 to 125 per cent of the "skin unit," the dose of 90 per cent representing the lowest permissible limit, not to be reduced if one expects to exert a curative action on a cancerous growth. During the last ten years we have always employed at least 110 per cent of the "skin unit" in the treatment of any carcinoma, for the adenocarcinomas we even raised the amount to 125 per cent. In biological terms, these values mean that with application of 110 per cent of the "skin unit," the skin responds with a pronounced reddening and even with a marked swelling of the follicles, while 125 per cent of the "skin unit" brings about vesiculation and subsequent desquamation.

One may deduct from these statements that it is by no means easy to apply in the depth of the body a dose which is necessary to destroy cancerous growth.

The intensity of the roentgen energy, which we project into the body, is gradually reduced by absorption and by distribution over larger areas at increasing distances, according to the well-known inverse square law. At a focal skin distance of 30 cm we obtain in a depth of 10 cm a dose of 22 per cent of the surface dose. Therefore, we must radiate a cancerous tumor lying at such depth through several ports in

understood *cum grano salis*, as the radio-sensitivity of the cells of ovarian follicles, the cells of lymphatic glands, of spleen, of blood and of the intima cells of blood vessels is appreciably higher than that of some cancer cells

Another error should be mentioned here radiotherapy is a local measure, first and last. The action of rays on the general organism and its defense mechanism is of minor importance. Therefore, the primary effect of the roentgen rays is the destruction of cancer cells locally. The old opinion that roentgen rays stimulate the connective tissue to the extent of strangulation of the cancer cells is erroneous. Neither can the general defense of the organism be stimulated to dissolution of cancer cells by any type of proteolysis, nor products of disintegration of cancer cells produce disappearance of tumors.

The surgical extirpation of a cancerous tumor is justified only if one adopts the point of view that cancer, at the onset, is a local disease. Those believing that new-growth is only a symptom of a systemic cancerous disposition cannot expect a local measure, such as a surgical operation, to be successful.

The same applies to radiotherapy, which, too, is a local measure. The action of the roentgen rays, however, reaches appreciably farther than that of the bistoury.

Though we assume that cancer is a local disease at the start, we do not dispute the statement that constitutional factors play a certain rôle in its genesis. However, it is not necessary to postulate that wide fluctuations in its dissemination throughout the organism are induced exclusively by systemic disposition, the original site of the new-growth, its relation to the surrounding tissues and, very frequently, medical interference favoring dissemination, suffice to give a satisfactory explanation for the spreading of cancer. Beside, new-growth is favored not only by a good blood supply of the affected part, but also by a well-developed lymphatic system.

It has been proved long ago that roentgen rays have a local action, which is

limited strictly to their beam. If a dose necessary for the destruction of carcinoma were applied to one portion of a tumor only the typical subsequent alterations of cells could be seen only in this radiated area, while the other part of the tumor not radiated would show no signs of regression. On the other hand, the claim is undoubtedly justified that there are available quite a number of most promising measures, which accelerate resolution of a properly radiated cancer, as, for instance, medication of endocrine preparations.

In the problem of roentgen cure of cancer, two important phases should be recognized:

- 1 Destruction of the localized growth, together with detoxication and elimination of cell debris
- 2 Repair at the site of the destroyed neoplasm by normal tissue and compensation for the damage created in the organism by the tumor, its toxins, and also by the roentgen rays

The term "destruction" should not be conceived in its narrowest interpretation, conveying the implied idea of a sudden effect. Proper radiation does not induce such a sudden effect, as it results, for instance, from thermocauterization, this procedure alters the tumor immediately and most visibly, so that the cells appear to be damaged distinctly. In the case of a well-directed roentgen radiation, however, one does not see any immediate macroscopic change, nor can one find microscopically any *specific* alterations, even after a delay of a few days.

(The pronounced alterations of cells brought about by radium are due to extreme over-dosage, a "caustic effect.")

The point of attack of the roentgen rays in the cell is the nucleus. Cells are most radiosensitive in the karyokinetic stage. Any tumor, of course, contains cells in various developmental stages, consequently the action of an exactly measured dose of rays on cells in different conditions varies.

If a tumor has received a very high dose

small doses can be demonstrated easily by the following experiment. A carefully measured "skin unit" is applied to two nearly identical small fields, perhaps one on each thigh, if, to the one this dose were applied at one sitting, to the other, however, in five sittings on subsequent days, 20 per cent at a time, the difference between the biological reactions would be striking. While the first area, irradiated at one sitting, would show the typical reaction to the "skin unit" with a marked tanning after six weeks, the second area, which had received the "skin unit" in the course of five days, would scarcely show any perceptible response. Thus, the reaction to such a fractionated dose corresponds to the effect of 80 per cent of the "skin unit" in a single application. In order to obtain by fractionated doses a reaction equivalent to that of the "skin unit" applied at one sitting, one has to increase the total amount in a certain ratio to the fractionation employed.

Such experiments show that scattering of a full dose entails reduction of its biological efficiency. Therefore, if one is compelled to distribute the necessary dose over several days instead of giving it at one sitting, one should compensate for the loss caused by the recuperative faculty of the cells by the application of the so-called "additional biologic dose." A similar diminution of the biologic efficiency becomes manifest, if one increases the distance between target and body in order to gain a more homogeneous depth dose, it is then not sufficient simply to calculate the time according to the inverse square law, but in order to obtain the same biologic effect an additional dose is necessary, which in case of a change from, for instance, 30 cm to 100 cm, should amount to 30 per cent of the calculated time.

This phenomenon of cell recuperation after application of sublethal doses explains why such high total doses are tolerated by those subjected to Coutard's method of treatment.

At first glance it seems to make no difference whether one applies a dose at one

sitting or distributes it over several days, if only due allowance is made for the recuperative faculty of the cells. But it really is not the same, for cell recovery depends on the tolerance of the individual cells, and thus, in turn, chiefly on their quite variable metabolism. The rapidly developing carcinoma cell is more radiosensitive, but on the other hand, it heals reparable injury more quickly. Cells of the connectivum, on the contrary, have a low radiosensitivity, however, they cumulate small doses to a higher degree than cancer cells.

In this type of tissue, therefore, the total effect of a fractionated dose is more intense than that of an equally large single amount of energy. One can express this experience also as follows: the ratio of radiosensitivity is altered by fractionation. The cancer cells become less radiosensitive, the cells of the connectivum, on the other hand, become more radiosensitive. But such a result is undesirable, for we should try to limit damage to the cells of the connectivum as much as possible, while cancer cells should be radiated by a dose guaranteeing their destruction. This is possible only by irradiation at one sitting. I think that all speculation with regard to Coutard's method is erroneous.

The opinion is held by some authors that by distribution of the dose over from ten to twenty days, the effect of roentgen treatment would approach that of radium therapy. But one overlooks the fact that the real difference in the effect of radium and roentgen rays is the lower absorptibility of radium rays, in other words, that their penetrating power is greater than that of roentgen rays, even with allowance for the Compton effect. This valuable quality of the radium rays cannot be obtained by fractionation and protraction of roentgen energy. There are now available for comparison sufficient data in publications reporting the results produced by my method of single dose radiation and by that of Coutard. The comparison is in favor of my method.

Two characteristic mistakes frequently

order to obtain by summation 110 per cent of the "skin unit" dose at the site of the tumor. In case of a tumor growing on the surface, sufficient concentration of radiant energy by the use of several portals of entry may at times prove nearly impossible. As the loss by absorption is fixed for given potentials and filtration, we must then attempt to reduce the inhomogeneity of intensity in such a superficially located area by other compensations. For instance, we choose a long focus-skin distance in treating breast cases, performing the irradiation from a distance of 100 to 120 cm. It would lead too far to enter into the discussion of the technical difficulties which arise as soon as we try to apply the cancer dose to various parts of the body, but I would like to say a word about the following locations: in a case in which a cancerous growth is situated in the center of the abdomen, as, for instance, a cancer of the uterus, one can adjust portals of entry in the form of a girdle, thus obtaining the necessary concentration in the depth. In anal cancer situated near the surface and surrounded by most uneven body levels, we often have to be satisfied with roentgen irradiation from one external perineal port and have to rely on a combination of roentgen rays, with radium for completion of the cancer dose throughout the neoplasm. Considering these difficulties of dosage, it is not astonishing that the results are very unsatisfactory in cancer of the anus, but they are much better in cases of cancer of the rectum situated about 12 to 15 cm. higher up. Its site in the center of the body is similar to that of a cancer of the uterus, so that it is relatively easy to apply the necessary dosage. Still more striking is the difference between the results obtainable in cancer of the cervix uteri and those in vaginal and vulvar cancer. In these cases we have to deal with the same histological type of cancer, *i. e.*, a squamous-celled epithelioma. But while we obtain five-year cures in about 70 per cent of the cases of cauliflower tumors of the vaginal portion of the cervix uteri, as long as the cancer is limited to the cervix, the results are quite

unsatisfactory in cases of vaginal cancer, in which roentgen therapy yields only 25 per cent of cures, about the same percentage as in cases of cancer of the vulva.

One might interject that the cancer of the cervix, which grows exophytically, is limited to its focus for a relatively long time, while, on the contrary, the cancers of the vagina as well as those of the vulva spread more rapidly into remote lymphatic channels, favored by wide lymphatic communications. I admit that these biological conditions play an important rôle with regard to the extension of cancer, but the differences in the results would not be so great if application of a proper carcinoma dose were easier. In cases of vaginal cancer, application of the cancer dose to the whole length of the vagina is not possible readily, because the intensity of a beam entering through a vulvar field diminishes rapidly toward the depth. Suprasymphyseal ports, on the other hand, project insufficient intensities to the lower parts of the vagina. Therefore, an additional dose of radium is necessary in vaginal cancer, while in cancer of the cervix we can do without such.

It is also important to know that cells become resistant to the action of roentgen rays, in case they survive a sublethal dose.

It has been proved long ago that regression of a carcinoma by radiation can be induced only with a true "carcinoma dose" as designated above. Nobody has ever observed a case of genuine cancer responding with regression to the application of small quantities of roentgen rays. In such purported cases of the older literature, an error in measurements seems to have occurred.

If we apply a small sublethal dose, the cancer cell is damaged, but this injury is repaired more or less rapidly. This same reaction will occur in all cells influenced, but the rapidly growing cancer cell with its high metabolism, is fitted better for such repair than a cell of the connective tissue stratum.

The extent to which cutaneous cells are able to recover from damage inflicted by

rapidly, the patient recovers more quickly and without complications

Local treatment of the radiated parts is also necessary. As the radiated skin produces little oil, ointment should be applied carefully to it. The intestinal mucosa too, recovers more quickly from the effects of radiation by roentgen rays if oil instillations are given frequently.

As to the after-care of the radiated cancerous tumor itself during the period of decomposition and regression, it should be regarded as a *noli me tangere*. Regression should not be disturbed by any measures. One should facilitate constantly the elimination of débris. Thus, vaginal douches are given regularly in cases of a voluminous and discharging cancer of the cervix uteri, in cancer of the rectum, the diseased part should be extirpated subsequently and daily lavages should be administered through an artificial anus.

In a similar way, in cancer of the breast post-irradiative extirpation of the tumor has proven beneficial. Beside furnishing the histologic information for our statistics, this operation provides a great relief to the organism, in sparing it the necessity of riddance of bulky débris.

Our statistics show that the process of regression is influenced favorably by good after-care. Years ago, we reported statistically on two equivalent groups of cancer of the cervix uteri treated by roentgen rays. The first group comprised women who, after irradiation, had to return to their work in poor and even miserable home conditions, when they had just started to recover, the second group dealt with women who could afford a long stay at the clinic or at a sanatorium. Permanent five-year cures in the second group were almost twice as frequent as in the first one. This result proves clearly the great influence of systemic after-care in cancer therapy.

This, experience has taught us that the systemic treatment of the organism should not be neglected in radiotherapy of cancer, it greatly contributes to a permanent cure. But on the other hand, it should

not be over-rated, for without correct application of roentgen rays success cannot be expected. All those non-surgical and non-irradiative methods of cancer treatment propagated these last years have proven to be absolute failures. However, it is true that the results of roentgen therapy are convincing only in carcinomas of certain location, especially in cancer of the uterus and of the breast. In many other types of cancer, the results are so unsatisfactory that cures can be considered only as occasional chance results. But in spite of this, I claim that there are no refractory types of cancer. These last ten years have shown that many a so-called refractory form of cancer responded very well to an improved technic in irradiation. There are differences in radiosensitivity of the various cancer types. However, these quantitative differences could be established only after the dogma of refractory cancer had been relinquished. Good biologic studies on the reaction of the individual cancer types to roentgen radiation, and investigations concerning the collaboration of the organism in the healing of the defect caused by radionecrosis of cancer are based on the fact that cancer cells perish after application of a certain dose of rays. In case this anticipated reaction does not occur, one should not accuse mysterious biologic factors, but rather search for the cause of this misfortune.

Undoubtedly, it means increased responsibility to hold forth the conviction that our errors are responsible for failures, and not the roentgen rays *per se*.

I should like to add a few words about radiation injuries. Thanks to a well-developed dosimetric system, the period of severe injuries, especially of so-called burns of the skin, is past. But, as in cancer therapy, the skin must be loaded with rays to the limit of its tolerance, and it is necessary to know the mode of reaction of the skin in order to be able to avoid injuries.

The acute injury, the "burn," is caused by over-dosage. Aside from this, latent damage is always inflicted which is not manifested by a destruction of the skin or

account for failure of roentgen therapeutic efforts in cancer treatment

- 1 Application of dosage insufficient for destruction of cancer cells because of ignorance of the biologic recuperative capacity of these cells
- 2 Such cumulation of radiation that not only the neoplasm is destroyed, but also severe injury is inflicted to surrounding healthy tissue, the biologic radiosensitivity of which has been increased simultaneously so that it is no longer able to repair the defect

Concomitant inflammation has an influence similarly unwelcome to that of fractionated doses. It is to the credit of Regaud and his collaborators to have shown the deleterious action of inflammation in cases treated by radium. Subsequently, we proved experimentally that relative radiosensitivity is altered by a coincident inflammation. The cancer cells become less radiosensitive, while the susceptibility of the surrounding healthy tissue is increased. For this reason, infected carcinomas may not regress if a dose of 110 per cent of the "skin unit" is applied, which, under normal conditions would be efficient. But if the dose is increased, there is danger of damage to the healthy surrounding tissue.

In order to avoid failures in cases of infected cancer, it is necessary to reduce the inflammation before radiation, as far as that is possible. It is not easy to obtain a satisfactory result quickly. Besides, one dare not lose too much time with disinfection measures, while the growth continues its development.

In cancer of the uterus, douches with rivanol and chinisol are useful, but by far the best results are obtained by our copper treatment on account of its deeply penetrating disinfecting action. The technique is the following: by means of a special electrode serving as the anode, the introduction of a solution of cuprum selenicum is induced. Thus, particles of copper and copper salt are incorporated into the tumor by iontophoresis.

Though it has been proved that these measures are useful, inflammatory carcinomas, indeed, offer a less favorable prognosis with regard to a permanent cure.

I referred above to failures caused by a dosage insufficient to bring about complete destruction of the tumor. It is necessary that the required dose be applied not only to the primary tumor, but also to the whole lymphatic region involved. This is not always possible, as there may be cases in which the full dose cannot be given over the whole region and others in which healthy tissue is damaged by over-dosage.

The task we undertake in treating cancer is not finished when we have applied the correct dosage. In order to secure satisfactory results by roentgen treatment, a systematic after-care should be employed.

The decomposition of cancer cells liberates toxins, besides, the organism is also loaded with products of metabolism produced by normal cells which have undergone the exposure to roentgen rays. This toxicosis becomes manifest as roentgen sickness (*Röntgenkater*) immediately after the irradiation. In most cases this symptom passes quickly, but there is many a patient suffering from this intoxication for some time. Therefore, it is necessary to control elimination before beginning irradiation, the function of the kidneys should be stimulated and the evacuation of the bowels taken care of. As a momentary measure of relief in cases of roentgen sickness, the intravenous injection of hypertonic solutions is employed at my clinic, later on, a rich supply of fluids is recommended, in order to cleanse the organism, last but not least, diuresis should be stimulated. For several weeks after radiation we give intravenous injections of colloidal sulphur, because the elimination of albumin debris is facilitated if there is an abundance of sulphur in the organism. We also prescribe sulphur *per os*, tending to improve elimination. A stay in high altitudes has a favorable effect, because a difference of 1,000 meters increases metabolism. Thus all debris is eliminated.

GIANT-CELL TUMORS OF THE SPINE

WITH REPORTS OF THREE CASES¹

By G E RICHARDS, M B, F R C P (Can), F A C R, and A C SINGLETON, M B,
Toronto, Canada

From the Departments of Radiology, University of Toronto and Toronto General Hospital

THIS interesting tumor has been known for many years under a wide variety of names. Nelaton (12), in 1860, was apparently the first to recognize its benign character and to separate it from malignant bone tumors under the caption of "tumeur a myeloplaxes." There has been and still is some contention that this is not a tumor at all but merely bone reaction to hemorrhage, so we find it referred to by Bloodgood and others as "hemorrhagic osteomyelitis." For many years the benign character of the lesion was opposed by many observers and the presence of a malignant variety is still maintained by many outstanding men. We find the condition referred to in the older British literature as "myeloid sarcoma" or "myeloma," and in the American literature as "giant-cell sarcoma." The work of the original Bone Registry Committee of the American College of Surgeons brought order out of this confusing multiplicity of names and ideas by establishing the fact that it is a clinical entity, neoplastic in origin and benign in nature. Their terminology of benign giant-cell tumor is now almost universally accepted.

This condition is relatively uncommon, occurring probably half as frequently as primary malignant bone tumors. It has a rather characteristic age incidence, the majority of the cases occurring in the latter half of the second and the third and fourth decades. The sexes are about equally affected, though some observers find it to be slightly more common in women than in men. The sites of involvement, in their order of frequency, are lower end of femur, upper end of tibia, lower end of radius, the

epiphyses of other long bones, the jaws, and the spine. Kolodny (9), in his analysis of the Bone Registry material in 1927, found the spine to be the seat of the lesion in 8 per cent of cases of benign giant-cell tumor.

The radiological findings in the majority of cases of this disease are striking and characteristic. The lesion practically always involves the epiphysis of the bone, is central in origin and expansile in type, and is frequently asymmetrical, one condyle only of a bone being involved. Cortical destruction and expansion of periosteum, with subperiosteal new bone formation, produces a "blown out" appearance. The line of demarcation between the tumor and normal bone is usually sharp and clean-cut and may be marked by a thin shell or rim of condensed bone. Coarse, bony trabeculae throughout the tumor give it the characteristic loculated appearance in the radiographs.

As well as this group which produces this characteristic appearance, there occurs another group, less numerous, which presents none of these radiological findings, yet which, on surgical exploration and on microscopic examination, are typical benign giant-cell tumors. Isolated reports of this type of case have appeared in the literature, and Kirklin and Moore (8), in an analysis of benign giant-cell tumors seen at the Mayo Clinic, found 50 per cent of their cases to be of this character. They gave it the name of "lysis" type of benign giant-cell tumor. These lesions are frankly osteolytic with no attempt at bone repair. The cortex is usually completely absorbed and the demarcation between tumor and normal bone is not very sharp and no trabeculation is present. These

¹ Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

of other tissues, but which produces a change in the sense of creation of a *locus minoris resistentiæ*. Coincidental, otherwise harmless injury may vulnerate such weakened tissue severely. In general, we assume, that the skin tolerates a dose of 100 per cent of the "skin unit." From eight to ten days after irradiation reddening shows and from four to six weeks later, tanning, the consistency of the skin undergoing no change. But if such a radiated skin is treated with heat or if 100 per cent of the "skin unit" is applied three times at intervals of six weeks between the applications, a condition of the skin occurs which we call "induration." The skin becomes thick like leather, it looks as if some liquid had been injected under high pressure. Such tissues then have become defenseless, and if, for instance, infection befalls them, necrosis ensues.

Induration is caused by injury of the vascular system. The intima of the blood and lymph vessels is very radiosensitive. Therefore, any tissue which has been irradiated with a dose near the limit of tolerance, carries a latent insult. We also speak of lesions caused by combination or

summation of factors, meaning that exogene or endogene noxa of some or other type may coincide with a latent roentgen injury. The late roentgen lesions mentioned in the literature, which become manifest long after irradiation without any evident cause, are nearly always brought about by summation. But an efficient prophylaxis may be practised in order to avoid such lesions. The patient should be told that the radiated parts of the skin as well as of the underlying tissue, are more sensitive and less resistant than normal ones. A well-organized after-care should attend to the radiated region and avoid the coincidence of some other noxa.

Great experience and comprehensive knowledge are necessary in order to avoid mistakes and errors. Close collaboration with surgery and the other branches of medicine is of importance. Results will be satisfactory only if roentgen therapy is practised as a humane and courageous "art," cherished affectionately, studied diligently, and executed deliberately to its final consequences, never if resorted to merely as a last but hopeless effort in an ill conceived and timidly performed experiment.



Fig 5 (left) Case 2 Miss A M S Oct 22 1936 Film shows benign giant-cell tumor of the first lumbar body, lysis type Note destruction of lateral aspect of body of first lumbar vertebra and destruction of pedicle and lamina of transverse process

Fig 6 (center) Case 2 Oct 22 1936 Lateral view of same case shows involvement of posterior half of vertebral body, pedicle and lamina

Fig 7 (right) Case 2, Photomicrograph, $\times 200$ from biopsy removed Oct 28 1936

Case 1 The surgical and pathological aspects of this case have been previously reported by MacFarlane and Linell (10) The patient, A M, a white male 35 years of age, was admitted to the Emergency Department of the Toronto General Hospital on Oct 22, 1931, and gave the following history In the evening prior to admission, while attempting to crank his car, the engine back-fired He felt something "snap" in his neck and had pain in the neck and back of his head, associated with limitation of movement There had been no symptoms prior to the injury

Radiological examination revealed a compression fracture of the third cervical body, associated with definite pathological changes in this vertebra Normal bone striation was replaced by a coarse, loculated trabeculation, giving a definite multicystic appearance The cortex was intact, apart from the area of fracture, but anteriorly the cortex of the body bulged forward and the posterior cortex protruded slightly backward The total bone density of this vertebral body was definitely decreased (Fig 1) The character of the lesion led to a radiological diagnosis of benign giant-cell tumor of the third cervical body Thorough clinical and radiological investigation failed to reveal any evidence of other bone disease or of a primary car-

cinoma A further radiological examination made on Nov 19, 1931, four weeks after his injury, showed absorption of the upper three-fourths of the third cervical body with formation of a definite kyphosis (Fig 2)

Two weeks after this x-ray examination, radiation therapy by high voltage x-ray was commenced The patient received 600 r measured on the skin to each of three portals, centering on the third cervical body He was discharged from the hospital finally on March 9, 1932, at which time his third cervical body was completely absorbed, except for a fringe of its inferior cortex (Fig 3) At this time he was wearing a light support and was free of any clinical symptoms Some three months later, after returning to work, he was thrown from a truck and sustained a fractured skull from which he died Autopsy proved the lesion in the third cervical vertebra to be benign giant cell tumor It also proved the cause of death to be his fractured skull and not compression of the spinal cord at the site of his tumor Microscopic section from the third cervical body shows benign giant-cell tumor (Fig 4)

Comment—The marked lysis of bone in this case occurred before radiation therapy was commenced Similar bone absorption

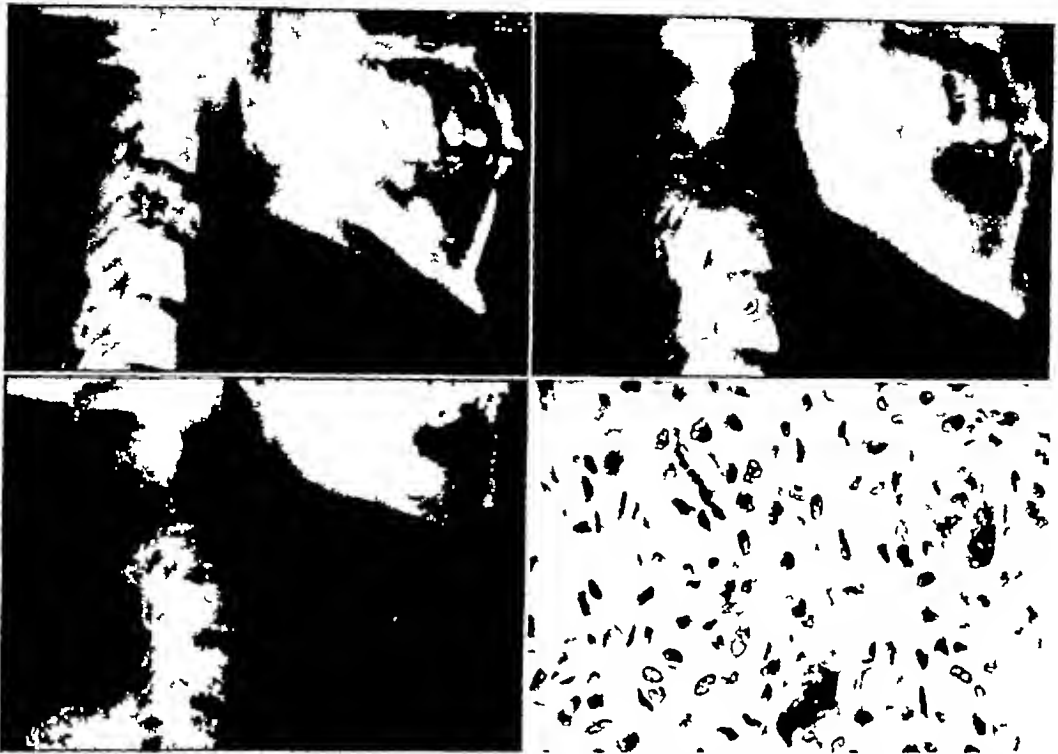


Fig 1 (*upper left*) Case 1 Mr A M, Oct 22 1931 Film shows benign giant-cell tumor of the third cervical body with pathological fracture Note characteristic multi loculated appearance of the tumor

Fig 2 (*upper right*) Case 1, Nov 19 1931 Film shows benign giant-cell tumor of the third cervical body Note marked absorption of bone in the third cervical body with collapse and kyphosis at this point No radiation treatment had been given prior to this date

Fig 3 (*lower left*) Case 1 Jan 22 1932 Six months after radiation treatment by means of high voltage x-ray The bone absorption and the kyphus are still present The patient is symptom free

Fig 4 (*lower right*) Case 1 Photomicrograph of benign giant-cell tumor of the third cervical body

findings are frequently found associated with a short clinical history, so that these are probably more rapidly growing tumors which do not allow time for the typical reactive bone changes to take place. Such a case is usually mistaken for one of the primary malignant newgrowths of bone or for secondary tumor, to which there is close resemblance.

Cartilage, either epiphyseal or articular, seems to offer definite resistance to the disease process, whether it be the ordinary or the lytic type, consequently, the process is usually limited to the epiphysis if the epiphyseal line is not fused and extension to adjoining joints is an uncommon and late complication. Pathological fracture is relatively common, particularly in weight-bearing bones, and may be the first indication of disease.

Allowing for differences in anatomical structure, benign giant-cell tumors in the spine present the same characteristics. The disease may arise in any part of a vertebra and extend to adjoining other parts by direct continuity. There seems to be a special tendency for pedicles and transverse processes to be involved. The cartilage of the intervertebral disc is usually intact, even though the whole vertebral body may be involved. Both types of tumor, described above, may occur in the spine and in both types diagnostic difficulties are definitely increased due to the multiplicity of bone lesions which commonly affect this structure. The relative infrequency of this tumor in the vertebral column and the difficulties attending its correct diagnosis have prompted us to report the following three cases.

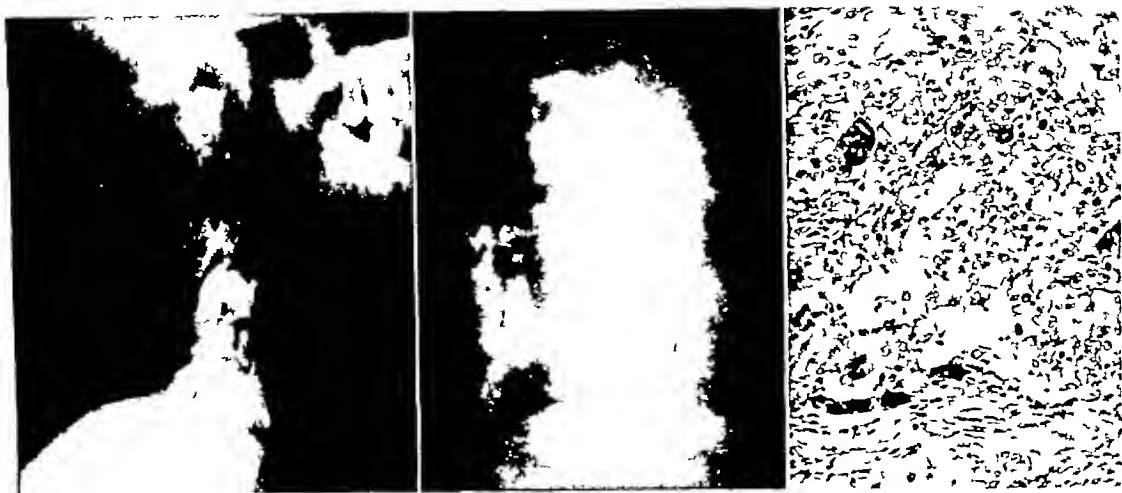


Fig 10 (left) Case 3 Miss Des L., Aug 4, 1934 Malignant giant-cell tumor of entire fifth cervical vertebra and of the body of the second cervical vertebra Note irregular cancellous and cortical destruction

Fig 11 (center) Case 3 Aug 4 1934 Malignant giant-cell tumor of the second third, fourth and fifth lumbar vertebrae, with pathological fractures of the third and fifth bodies

Fig 12 (right) Case 3 Photomicrograph of Case 3, $\times 200$ This was reported pathologically as giant-cell tumor (xanthosarcoma)

series of high voltage x-ray treatments was carried out, giving 1,200 r over each of three portals centering on the first lumbar body Subsequent films made ten weeks later, April 5 (Fig 9), showed a very marked degree of bone regeneration throughout the tumor At this time the patient had full range of painless movement in her back and was allowed up out of bed

Comment—This case presents a number of interesting features, as well as its unusual radiographic appearance The patient's age of 13 years is well below the average for this tumor The absence of increased bone absorption and the very prompt response to treatment in the form of bone production are unusual and encouraging, and the patient should go on to complete regeneration of bone

Case 3 C D L., a white female, 28 years of age, was admitted to the Ontario Institute of Radiotherapy, Toronto General Hospital, on Aug 3, 1934 She gave a history of pain and weakness in her back for two years and soreness in her chest, neck, left arm, and pelvis for six months During the six months prior to admission she had lost 27 pounds in weight

Physical examination revealed tender-

ness over the cervical, mid-thoracic, and lumbar spine with painful limitation of movement, a palpable mass in the region of the posterior superior spine of the ilium and a mass of glands in the left side of her neck

Radiological examination of the cervical spine showed pathological changes involving the entire fifth cervical vertebra The changes consisted in irregular, globular areas of bone destruction, cortical and medullary, throughout this vertebral body and extending backward to involve pedicles, laminae, and spinous process The picture was complicated by the presence of pathological fracture There was no involvement of the intervertebral disks above or below the fifth cervical vertebra The second cervical vertebra showed a rather large single area of bone destruction, involving the anterior part of the body and extending upward into the odontoid process (Fig 10) Films of the remainder of this patient's skeleton showed similar destructive changes in the eighth, ninth, eleventh, and twelfth thoracic vertebral bodies, in numerous ribs, in the third, fourth, and fifth lumbar vertebrae, in both ossa innominata and the sacrum Pathological

and apparent extension of disease frequently occurs shortly after institution of radiation therapy to these tumors, to be

without any reactive bone changes in the vertebral body, nor any periosteal reaction. No trabeculation was present with-



Fig 8 Case 2 Jan 18 1937 Benign giant-cell tumor 'lysis' type of first lumbar body. This film was made ten weeks after surgical exploration and biopsy and interstitial radium therapy. Note bone regeneration in vertebral body and from periosteum of transverse process.



Fig 9 Case 2, April 5 1937. This film was made ten weeks after first series of high voltage x-ray therapy and three months after interstitial radium therapy. Note continued and marked bone regeneration in the vertebral body and transverse process.

followed later by bone regeneration. Treatment was effective in causing regression of the tumor and we feel, would have controlled unquestionably his disease if he had not unfortunately died of fractured skull.

Case 2 A. M. S., a white female 13 years of age, was referred to our office on Oct 22, 1936, for radiological examination of her lumbar spine. Her story was that while swimming, two months previously, she had slipped on a raft and "strained her back." Her back was somewhat "stiff" for a few days, then all symptoms disappeared to return after an interval of two or three weeks. For the past month she had had more or less constant ache in her back which had increased up to the time of her examination.

Radiographs of her lumbar spine showed a destructive lesion involving the left lateral and posterior aspects of the first lumbar body, the entire left pedicle and transverse process, and the major portion of the lamina on the left side. The lesion was entirely osteolytic in nature, cortex and cancellous bone both being destroyed

in the lesion and the line of demarcation between the lesion and normal bone was very indistinct. The intervertebral disks above and below the involved body were intact. There was no evidence of fracture, nor any evidence of an associated soft tissue mass (Figs 5 and 6). We felt that the findings were unquestionably those of primary tumor of bone but could not be certain as to its type.

On Oct 28, 1936, the lesion was explored by Dr. R. R. Graham who removed a portion of the tumor for biopsy. Microscopic examination of the tissue by quick section showed it to be a typical benign giant-cell tumor (Fig 7). At the time of the operation twenty 2-mg. radium element needles with filtration of 0.5 mm. of platinum were embedded by one of us (G. E. R.) in the tumor for a total dose of 4,800 milligram-hours. Films made ten weeks later, on Jan 18, 1937, (Fig 8), showed beginning bone regeneration in the vertebral body and lateral to the body in the region of the transverse process. At this time the patient was free of pain. A



Fig 15 (*left*) Mrs E M May 31 1934 Hodgkin's disease of the first second and third lumbar bodies with pathological fracture in the third

Fig 16 (*center*) Mrs J L Jan 30 1936 Neurofibroma of soft tissues producing rounded bone defects in the third and fourth lumbar vertebrae on the right side The bone defects are clean-cut with sharp demarcation between the area of destruction and normal bone

Fig 17 (*right*) Lateral view of patient shown in Figure 16

structive with no apparent attempt at bone repair The age of the patient may be of help in differentiating these cases as it is unusual to have malignant osteolytic tumors in young people, though the majority of these cases will require microscopic examination of tissue to allow of a positive diagnosis

Primary malignant tumors of bone and metastatic tumors are, of course, the most frequent sources of error in this group though rarer lesions occasionally enter into the differential diagnosis Hodgkin's disease of bone may rarely involve a single vertebral body and present a radiographic picture similar to these lytic tumors (Fig 15) Occasionally pressure from an overlying soft tissue tumor produces a crescentic bone defect with rather indefinite outlines which may be confused with primary tumor of bone, as in one of our recent cases (Fig 16) Here the bone defect was due to an encapsulated neurofibroma, lying immediately adjacent to the vertebral body

DISCUSSION

The question of malignant variants of giant-cell tumor of bone has been widely discussed and pathologists are divided in opinion in this regard Theoretically, ma-

lignant giant-cell tumor might occur in either one of two ways first, as a primary tumor malignant from its inception, and second, as a metaplasia from a simple benign giant-cell tumor That either of these processes occur is refuted by Geschickter and Copeland (4), who maintain that the cases of so-called giant-cell tumor which metastasize are in reality not giant-cell tumors at all, but osteogenic sarcomas containing numerous tumor giant cells With regard to metaplasia of a benign giant-cell tumor to an osteogenic sarcoma they point out that a benign giant-cell tumor recurring after curettage and with super-added infection may present a microscopic appearance which is indistinguishable from osteogenic sarcoma, yet which is still benign and does not metastasize

Contrary to this is the frequently quoted case reported by Ewing and Stone (3), in which a typical benign giant-cell tumor recurred after curettage and, following radiation treatment and infection, underwent malignant degeneration and killed the patient by metastasis Cases of malignant giant-cell tumor have also been reported by Coley (1), Peirec (14), Thurstan Holland (7), and others, so that, for purposes of treatment, we feel we must bear in mind that malignant tumors of this type

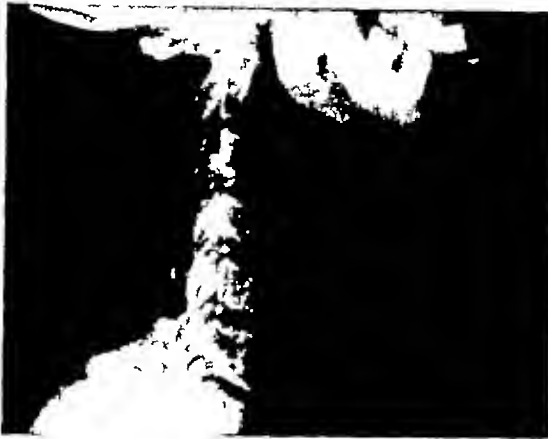


Fig 13 Mr C P May 23 1934 Hemangioma of the sixth cervical body which closely simulates benign giant-cell tumor



Fig 14 Miss I S April 20 1934 Ewing's sarcoma of the fifth cervical body with pathological fracture and paraplegia. Note close resemblance between this illustration and Figure 1 Case 1. In this case the diagnosis of Ewing's sarcoma was not considered until microscopic examination was done.

fractures were present in the lesions in the third and fifth lumbar bodies (Fig 11). There was no evidence of disease in either lung. The character and multiplicity of the lesions in bone and the absence of lung involvement in a woman of 28 years of age presented a nice problem in diagnosis. We felt that the differential diagnosis lay between secondary carcinoma and myeloma, with the weight of evidence in favor of carcinoma in spite of the absence of lung metastasis.

Microscopic examination of tissue removed for biopsy led to the pathological diagnosis of giant-cell tumor (xanthosarcoma) (Fig 2).

Comment—This case may be used to illustrate the discrepancy which is occasionally seen between clinical and radiological findings on the one hand and the microscopic findings on the other. There will be some who will argue that this case is not giant-cell tumor at all, and others will accept it as representing that group of tumors which may be termed "malignant giant-cell tumors" or "giant-cell sarcomas." Certainly these cases are vastly different from benign giant-cell tumors clinically and in their radiological findings, and must be considered as a separate group for purposes of treatment and prognosis.

DIFFERENTIAL DIAGNOSIS

Benign giant-cell tumors, when situated in their usual location in the epiphysis of long bone and presenting the characteristic radiological findings discussed above, do not usually offer much difficulty in diagnosis. However, even in long bones and particularly in the spine, their x-ray picture may be closely simulated by a number of other lesions of bone. Hemangioma of vertebral body, while usually producing perpendicular striations without cortical expansion, may at times present globular loculation, suggesting benign tumor (Fig 13). We have observed Ewing's sarcoma of the fifth cervical body to resemble benign giant-cell tumor so closely that the correct diagnosis was established only by microscopic examination of tissues removed at laminectomy, done in the hope of relieving paraplegia (Fig 14). Even secondary carcinoma of the spine may closely approach the characteristic appearance of giant-cell tumor, and if one vertebral body only is involved the differentiation may be very difficult.

Even greater difficulty in differential diagnosis is presented by those cases which do not present the usual radiological findings—the so-called lysis type of giant-cell tumor in which the lesion is purely de-

CONCLUSIONS

1 Two types of benign giant-cell tumor of the spine are described and some of the difficulties of radiological diagnosis in each type are discussed

2 Two microscopically proven cases of benign giant-cell tumor of the spine, illustrating these different types of tumor, are reported

3 The value of radiation treatment in benign giant-cell tumors of the spine is indicated

4 One case of malignant giant-cell tumor of the spine is also reported

BIBLIOGRAPHY

- (1) COLEY, WILLIAM B Malignant Changes in the So-called Benign Giant-cell Tumor *Am Jour Surg*, June, 1935, 28, 768-820
- (2) EWING, JAMES The Place of Biopsy in Bone Sarcoma *Am Jour Surg*, January 1935, 27, 26-28
- (3) EWING JAMES, and STONE W S An Unusual Alteration in the Natural History of a Giant-cell Tumor of Bone *Arch Surg* September 1923, 7, 280-296
- (4) GESCHICKTER, C F and COPELAND M M

Recurrent and So-called Metastatic Giant-cell Tumor *Arch Surg* May 1930, 20, 713-755

(5) HERENDEEN, R E The Roentgen Ray in the Treatment of Giant-cell Tumors *Am Jour Roentgenol and Rad Ther*, 1930, 24, 648-656

(6) Idem Results in the Roentgen-ray Therapy of Giant cell Tumors of Bone *Ann Surg*, January 1931, 93, 398-411

(7) HOLLAND, C THURSTAN The Benign Giant-cell Tumor of Bone *British Jour Radiol* April 1934 7, 227-232

(8) KIRKLIN, B R and MOORE S Roentgenologic Manifestations of Giant-cell Tumor *Am Jour Roentgenol and Rad Ther* 1932, 27, 145

(9) KOLODNY A Bone Sarcoma and the Giant-cell Tumor *Surg Gynec and Obst* April 1937

(10) MACFARLANE J A, and LINELL E A Benign Giant-cell Tumor of Third Cervical Vertebra Case Report *British Jour Surg* January 1934 21, 513-518

(11) MARTIN, H E and ELLIS, E B Aspiration Biopsy *Surg, Gynec and Obst*, October 1934 59, 578-589

(12) NELATON, E Tumeur Benignes des Os Paris, 1860

(13) PFAHLER, G F, and PARRY L D The Treatment of Giant-cell Bone Tumors by Roentgen Radiation

(14) PEIRCE, C B Giant-cell Bone Tumor Consideration of the Morphology of this Neoplasm the Response to Surgical and Radiation Therapy and Report in Detail of Two Malignant Cases *Am Jour Roentgenol and Rad Ther* August 1932, 28, 167-188

(15) Idem Giant-cell Bone Tumor Some Considerations of Treatment *RADIOLOGY*, October 1933, 21, 348-351

do occur For practical purposes, whether they are microscopically malignant giant-cell tumors or osteogenic sarcomas is of less moment, as the response to treatment and the prognosis remain the same In many of these questionable cases there are unusual features, in the clinical history, the location of the lesion, or the age of the patient, to mark them from the onset as unusual

One cannot discuss the radiological findings of any group of bone tumors without considering also the value and advisability of doing biopsies A careful clinical history, taken in conjunction with a thorough and competent radiological investigation, will differentiate benign from malignant bone tumors in at least 80 per cent of cases In certain of the remaining cases the pathologists also may have great difficulty in deciding this point, as a great many of the cases in which clinical and radiological examinations fail are problem cases, being atypical and unusual The taking of biopsies in cases of bone tumors has been opposed by a number of pathologists, notably Ewing (2), because of the dangers of infection and the feeling that dividing the natural barriers, notably periosteum and cortical shell, leads to earlier local extension and generalized dissemination of the disease The danger of infection has been definitely lessened by improvement of surgical technic in bone cases, but its possible occurrence must always remain Aspiration biopsy, as evolved by Martin and Ellis (11), probably reduces the dangers of biopsy, both real and theoretical, to a minimum, and this method should prove to be very satisfactory in giant-cell tumors in which the cortical shell is thin

In tumors of the spine in which surgical excision is impossible, the practical value of biopsies is much less as conservative methods of treatment must be employed, regardless of the type of tumor present

The treatment of giant-cell tumor of bone has shown progressive improvement with changing conceptions of the pathology of this lesion For many years, before the benign nature of the tumor was realized,

amputation was the universal method of treatment and unquestionably this fact contributed, to a considerable extent, to the earlier statistics of cures in cases of bone sarcomas Later, local resection of the lesion was done and this was followed by the operation of curettage Later still, in an effort to prevent recurrence following curettage, the cavity was swabbed out with an escharotic—either zinc sulphate or carbolic acid followed by alcohol This method has given good results in the majority of cases but is not without definite drawbacks in the possibility of hemorrhage and infection and the certainty of recurrence in a considerable number of cases Geschickter and Copeland (4) report 31 recurrences after a single curettage in a series of 222 cases, or 14 per cent, while Kolodny (9) states that recurrence takes place in approximately 20 per cent of cases following single curettage

Since Pfahler (13), in 1906, first treated a case of benign giant-cell tumor of bone by x-ray, radiation therapy has been slowly gaining ground and has been given great impetus by the excellent work of Herendeen (5,6), Pfahler and Parry (13), Peirce (15), and others The response of these tumors is usually slow and is frequently preceded by a stage of lysis and apparent extension of the disease, to be followed by bone regeneration and repair

While controversy may continue as to the relative merits of surgical and radiation treatment of benign giant-cell tumors of long bones, there can be little question that radiation must be the method of choice when the disease affects the spine Cases 1 and 2, here reported, both show clearly the value of radiation therapy in this condition, though the patient reported as Case 1 died before the treatment could be followed through to conclusion and the patient reported as Case 2 has been under treatment for too short an interval to allow of anything but a preliminary report Her progress so far has been very encouraging and a good final result is almost certain

Nevertheless while these facts have been available in print from 1922 on, they still have not penetrated into the general field of practical therapy, and old-fashioned methods are still used by the majority of radiotherapists. To Regaud is due the stress laid upon the rate of giving of radiation both with x-rays and gamma rays and he and his co-workers formally established the fact that better results are obtained by prolonging the dose with either type of radiation over a considerable period, though the exact details for the individual patient still escape a definite formulation. In other words, the treatment must be adapted to the individual and no dogmatic and general rules are as yet possible.

However, the collection and publication of a large amount of clinical material is beginning to show, as Coutard has repeatedly said, that rapidly growing tumors should be treated somewhat more intensively than the slow-growing, presumably dependent upon the fact, as pointed out by Bergonié and Tribondeau, that mitotic cells are more sensitive than resting cells and in slow-growing tumors the period of radiation must be extended considerably as the mitoses are infrequent and few, and the tissues of the tumor must be kept nourished, so to speak, to preserve all the normal structures in order to obtain permanent results. Too rapid and too intense dosage shuts off the blood supply from the tumor and quickly renders the normal tissues so sensitive to radiation that doses destructive for the tumor cells soon become impossible.

From careful studies of the rate of administering radiation made by Coutard and by Holthusen and his collaborators on human material, the absolute necessity for a low rate of giving of x-rays is now generally acknowledged, though practically still but little used. Thus we see in a recent number of *RADIOLOGY* the statement by an experienced clinician that equally good results are obtainable by giving x-rays at the rate of 15 or 20 r per minute or even higher as are obtained with a slower rate of 3 or 4 r per minute though this was demonstrated as untrue by Regaud and

Holthusen. Eight years have elapsed since proof of this fact and still it has not penetrated into practical therapy. An obvious hindrance to practical application is the length of time required to make the exposures and, hence, diminution of the number of patients who can be treated.

This statement applies only where an attempt is being made to produce a permanent cure, which implies the destruction of all living cancer cells. In cases in which simple palliation is the only result that can be expected, the radiation can be given more rapidly, provided it is properly spaced in time.

Another hindrance to the use of the Coutard method has been the insistence of the author on the fact that serious lesions of the skin and mucous membranes are essential for the production of a cure. It is still being held by many courts that a skin lesion from radiation is an evidence of malpractice, a position as antediluvian as to assume that the scar of an abdominal incision carried the same legal liability. But the necessity for serious lesions is not true in all instances, as cures can often be obtained without them if the administration of the radiation is sufficiently slow, the spacing properly judged, and the skin not hypersensitive. For there are patients with skins so sensitive that 3,500 r, given at a rate of 4 r per minute and only 200 r applied daily, will result in such a severe injury that the treatment has to be abandoned. However, this situation can be obviated provided radiation at higher voltages is available and the same patient whose skin was damaged by a dose of 3,500 r at 200 kv, is able to receive 8,000 r at 4 r per minute and 200 r per day when the voltage is 800 kv.

This raises the question of the value of the higher voltages. The reason why radium has been considered so much more effective than x-ray has been due to two facts: that the average 4-gram pack at 10 cm does not give a rate higher than some 4 to 5 r per minute on the skin and, secondly, that gamma radiation is equivalent to a voltage of about 2,000,000. With such

THE TREND IN RADIOTHERAPY OF CANCER

By FRANCIS CARTER WOOD, M.D., *New York City*

Director of the Institute of Cancer Research, Columbia University, Director of the Radiotherapeutic Department, St. Luke's Hospital, Consulting Radiotherapist to the Presbyterian Hospital

THE biological effects of radium and x-rays were discovered by the production of accidental injuries. Marie Curie's hands never recovered from their damaged condition, the result of contact with the radium she was isolating, though it was Becquerel's historic burn that drew direct attention to the destructive capacities of this agent. The lesions from x-rays of the early patients and operators are well known, but x-ray cancer of the operator became a thing of the past with the introduction of the hot cathode x-ray tube, the output of which can be controlled at a distance. Patients may still have x-ray cancers as a result of treatment, but there will be no more martyrs among operators.

The therapeutic value of radiation came later. The chief advance in the use of radium in the early days was the introduction by Dominici of the principle of heavy filtration, but the extraordinary time lag which is observed between scientific discoveries and their practical application prevented for more than ten years an intelligent use of the facts pointed out by Dominici. The development of the use of x-rays was likewise hampered for a longer period by a lack of application of the available experimental knowledge. Regaud and his co-workers had begun a series of studies on the effects of radiation on cells, but the most important contribution in which biological methods were used to study the effects of radiation is the monograph by Kronig and Friedrich, published in 1918. They carried on an enormous series of very intelligent experiments, but, owing to the difficulties in measurement of both the radium and x-ray intensity and the lack of suitable biological material, missed a number of important facts. For example, they found that filtered gamma

rays were four times more effective than an equal amount of x-radiation, but they noted the important fact that a far deeper skin erythema followed the application of a single dose of filtered roentgen rays than when one-tenth of the same dose was given on ten successive days, thus laying the foundation for divided-dose therapy. This passed more or less unnoticed and the tendency was to follow the dictum of Sertz and Wintz, and attempt to apply a single sterilizing dose to the tumor, which was computed at approximately 130 per cent of an erythema.

The firm basis for the application of this principle was laid down by Regaud (in a series of papers from 1906 to 1922), who showed that sterilization of the testicle in animals was followed by less damage to the skin when the treatments were divided into three or four successive applications. Regaud called attention to the rhythmic appearance of mitoses in tissues and pointed out that in the testicle a continuous feeble dose of radium might cause complete sterilization of a tissue by killing the mitotic cells only. This introduced the principle of avoiding damage to the healthy tissues but at the same time destroying the neoplasm. Under Regaud's direction Courtaud developed a practical technic for the treatment of human cancer and laid the foundation for the modern effective use of radiation.

At the same time Wood, Prime, and Packard were beginning their demonstration of the independence of the biological effect in relation to the wave length of the radiation used when applied in a single dose to suitable biological material. This was confirmed and amplified by Holthusen and his school in regard to the erythema dose on the skin.

whose susceptibility to the general effects of radiation is so great that they will refuse treatment. Curiously enough, the use of from 800 to 1,000 kv x-rays with 10×10 cm portals seems to give less x-ray sickness in dosages of 200 r than the corresponding 200 kv radiation. Perhaps, as Stone has recently shown, this is because the scatter with the higher voltages is forward so that the prism of tissue irradiated is less in bulk than at the lower voltages where there is still a good deal of scatter out of the line of the direct beam. All these limiting factors have, up to the present time, prevented the effective treatment of any type of neoplasm, except of the skin, the cervix uteri, and certain oral and upper respiratory tract growths. For these, radiation is on an equal or better footing than surgery, as there are now a considerable number of five-year cures of carcinoma of the cervix by radiation though in an inoperable stage.

The trend of late years has been toward electrical engineering improvements in x-ray apparatus so that higher voltages are now at our disposal at a fairly moderate cost and these machines are to a certain extent replacing radium, as illustrated by the fall in the price of radium. But if radium were very cheap would it again return to its old popularity? This may seem a vain question, but the developments in experimental physics in the last year or two point to the possibility of the production of vast quantities of radio-active material by a relatively simple procedure, that of breaking up the atom of various substances by impacts with heavy hydrogen atoms. The machine which does this was invented by Professor Ernest O. Lawrence, of the University of California. He is now working with energies equivalent to about 6,000,000 volts and has produced approximately one kilo of radio-active sodium. It has a half-life of fifteen hours, hence is not particularly useful, though interesting experimentally as, in theory, it is possible to inject it into the body. But the injection of radio-active material into

the veins has never proved effective in the treatment of cancer nor even of leukemia and presumably never will, because circulation in the resistant types of growth which at present cannot be treated with x-rays is slow, and most of such injected sodium would be exerting its energies in destroying the kidneys, liver, and bone marrow, and only a small quantity would reach the tumor. But the production of these radio-active elements is a matter primarily of energy and so far it has been possible to produce small quantities of radio-active bismuth and vanadium, which have a longer half-life. If energies equivalent to 20,000,000 volts can be produced with this machine, there is no theoretical reason why the long life radio-active substances cannot be made. We are, in other words, within striking distance of the production of radium by the radiation of uranium.

The one difficulty with large quantities of radium has always been the question of protection, but recent developments in pack construction, such as that shown at the Fifth International Congress of Radiology in Chicago, demonstrate that both the patient and the operator can be completely protected from the radiation during the placing of the patient and the radium automatically substituted while the operator is safely out of reach behind thick lead walls.

It may be that in the future there will be a swingback to the employment of large quantities of these synthetic radio-active materials if the skin-radium distance can be the same as the skin-focus distance with x-rays, so that again radium will replace x-rays in many fields, especially for the radiation of internal growths over long periods of time. Cyclotrons of great capacity will shortly be constructed and the attempt to activate the elements of higher atomic weight will no doubt be begun within a year, so that soon it will be definitely known whether this most dramatic adventure in modern physics offers anything practical in the attack on cancer.

short wave lengths, even though the depth dose is much less than with x-ray, extraordinarily good results have been produced, but entirely without any appreciation of the scientific basis of this difference, which lies wholly in the fact that the back scatter from the tissues to the skin with gamma radiation is of the order of 5 per cent of the impinging dose, and this is also true of 800 kv γ -rays. With 200 kv γ -rays the back-scatter from the tissues to the skin is 45 per cent of the impinging dose. Thus in giving 200 r with 800 kv or with radium, only some 210 r units reach the skin, while with 200 kv a similar dose means approximately 290 r units in the skin.

This is the chief advantage of the use of the higher voltages of γ -rays and at 800 to 1,000 kv the clinical results are apparently perfectly equivalent to those of radium. There is the additional advantage that, owing to the approximately parallel beam obtained by the use of a long skin-focus distance of from 100 to 150 cm, such as is possible with the higher voltages of x-rays, the depth dose at 10 cm with moderate portals may be 50 or 60 per cent of the impinging radiation, whereas with the radium pack it is not more than 25 per cent of the impinging dose measured in air.

In cases in which many portals can be used these facts are not so vital for effective therapy because under these circumstances no excessive skin dose has to be given over any individual portal, but when the portals are limited, as in the treatment of cancer of the upper respiratory and oral tracts, the advantage is so considerable that it may determine the possibility of a cure which may not exist at the lower voltage radiations. Nevertheless the author has, by a careful study of the patient's condition, been able to cure a carcinoma of the larynx with 150 kv radiation by proper extension of the time of radiation and the use of small quantities, not over 3 to 4 r per minute, and a total of from 150 to 200 r per day. The reason for this is, of course, that the amount of penetration required is small in this site.

The sole advantage that radium pos-

sesses at present over the higher voltage γ -rays lies in the possibility of the insertion of highly filtered radiation into the substance of the tumor at the same time that heavy x-ray radiation may be applied through the skin. This condition does not exist in connection with a carcinoma of the larynx, hence the tendency to abandon radium for its treatment. Apparently for this particular form of neoplasm γ -rays will soon supplant surgical operation and will in many cases not only cure the patient but leave him in such shape that his ability to talk is not compromised. However, even in such a situation it is dangerous to generalize, and if the growth has already destroyed a considerable part of the vocal cord, complete restoration of the voice is obviously impossible.

This brings up the question of the limitations of radiocurability, which has recently been discussed in an excellent article by Lenz. In it he points out that notwithstanding all that has been learned in late years concerning the way in which radiation should be applied there are many conditions which interfere with effective treatment. Thus while it is possible to cure a carcinoma of the skin with ease, to the same type of tumor in the esophagus it is practically impossible to deliver an adequate dose, and even if effective radiation has been applied, the accident of perforation into the mediastinum—with the resulting infection—may cost the patient his life, although the radiation has destroyed the tumor. The existence of syphilis renders it almost impossible to apply a satisfactory amount of radiation to the tongue without causing extensive sloughing. In other words, the vessels which are damaged by the syphilis are also damaged by the γ -ray or radium and the resulting blood supply may be quite insufficient. Also, bone necrosis is not infrequent in the jaw if heavy dosage is given, especially in those who have infected tooth-roots. The easy induction of pulmonary fibrosis in addition to the high radioresistance of lung cancer prevents any effective therapy in this region. Again, there are patients

METHOD IN RADIOTHERAPY

By ARTHUR U DESJARDINS, M D , *Rochester, Minnesota*

From the Section on Therapeutic Radiology, The Mayo Clinic

DURING recent years the tendency among therapeutic radiologists has been to emphasize penetration. This tendency has now reached such proportions that other important factors often receive little or no attention. Almost everywhere there has been an increasing demand for more and more penetrating rays, and satisfaction of this demand has been sought in higher and higher potentials. In many parts of the country apparatus designed to generate roentgen rays at potentials from 600,000 to 1,000,000 volts, or even higher, has been installed and is being used to treat a variety of tumors. In a few institutions apparatus of this kind has been in use for five or more years, but in most places the installation of such equipment has been more recent.

Several factors have stimulated this desire for more penetrating rays. For many years radiologists had observed that while some malignant neoplasms, notably the epitheliomas of the skin, could be cured or greatly influenced by exposure to strong doses of rays generated at moderate or even at relatively low potentials (140 kilovolts or even 100 kilovolts), tumors derived from epithelial or connective tissue cells and situated in the depths of the pelvis, abdomen, or thorax, or in other regions, were influenced much less or not at all by the same doses or even by still larger doses of rays. No doubt, an important reason for this difference was that, with roentgen rays generated at potentials below 150 kilovolts, a considerable proportion of the beam of rays was made up of comparatively long wave lengths, and these were absorbed largely by the layers of tissue at or near the surface of the body. The beam necessarily contained a certain proportion of rays of shorter wave length, but the proportion of such rays was relatively small—too small to have a pronounced or lasting effect on deep and resis-

tant tumors. With a beam of rays generated at 140 kilovolts and filtered through 4 mm of aluminium, and with the target of the tube at a distance of 12 inches (30.5 cm) from the skin, the proportion of the surface dose reaching a depth of 10 cm was only about 18 or 20 per cent. Even with a beam of rays generated at 200 kv and filtered through 1 mm of copper, the proportion of the surface dose reaching a depth of 10 cm does not exceed 35 per cent. Nevertheless, even this moderate difference yielded noticeably superior results in the treatment of certain kinds of tumors deep beneath the surface of the body.

A second reason for the trend toward higher potentials has been the desire to avoid the deleterious changes in the skin often observed after strong doses of roentgen rays of relatively long average wave length. There is no doubt that, in this respect, the shorter the average wave length of the beam of rays the smaller is the effect on the skin and subcutaneous tissues because these tissues absorb a comparatively smaller proportion of the surface dose. Hence, larger surface and depth doses can be given with less likelihood of injury to the skin.

A third reason relates to the so-called selective action of roentgen rays of short wave length. This doctrine, formulated and promulgated by Regaud, was based on the point already mentioned that, when a beam of rays is directed to any part of the body, the shorter the effective wave length of the beam the smaller the proportion absorbed by the skin and subcutaneous tissues. Hence, the cells of the deeper tissues receive a correspondingly larger dose and are influenced that much more, or the same effect on deep tissues can be produced with a smaller dose—a quantitative dose insufficient to cause an inflammatory reaction in the skin. However, to ascribe to the rays the power of selective effect on cells is mis-

BIBLIOGRAPHY

HOLTHUSEN, H and BRAUN R Grundlagen und Praxis der Röntgenstrahlendosierung Georg Thieme Leipzig, 1933

KRÖNIG B and FRIEDRICH W Physikalische und biologische Grundlagen der Strahlentherapie Urban & Schwarzenberg Berlin 1918

LENZ M Present Limitations of Radiocurability of Cancer Acta of the Unio Internationalis contra Cancrum, 1937, 2, 265

PACKARD, C The Quantitative Biological Effects of X rays of Different Wave Lengths Jour Cancer Research 1927, 11, 1

REGAUD C Le rythme alternant de la multiplication cellulaire et la radiosensibilité du testicule Compt rend Soc de Biol 1922, 86, 822 and the chapter on

Histophysiologie des radiations Arch de l'Institut du Radium, 1927, 1, 1-132

SEITZ, L, and WINTZ H Unsere Methode der Röntgen-Tiefentherapie und ihre Erfolge Strahlen therapie, Supple 5 Urban & Schwarzenberg, Berlin 1920

STONE R S and AEBERSOLD PAUL C Clinical Deductions from Physical Measurements of 200 and 1 000 Kilovolt X rays RADIOLOGY September, 1937 29, 296-304

WOOD F C Further Studies in the Effectiveness of Different Wave Lengths of Radiation RADIOLOGY 1925 6, 1

Idem The Biological Dosage of X ray Med Record, 1922 101, 399

Idem Biological Determination of Radiation Dosage Jour Radiol 1922 3, 37

know little about radiotherapy and justify their deficiency by minimizing its importance. When they are called upon to treat a patient, some are not honest enough to admit their deficiency or lack of interest. They proceed to treat the patient, but the treatment often is inferior, and the results are what might be expected under the circumstances.

During the last fifteen or twenty years, however, the rapid increase in our knowledge of the action of roentgen rays and radium on different kinds of living tissue has attracted more and more attention, and it has caused some of the older and many of the younger radiologists to realize that a medical field of considerable scope is in the making. Unfortunately, many have ventured into this field with insufficient technical preparation, or even with an inadequate background of anatomy, physiology, and pathology.

Working as so many do in quarters more or less remote from those devoted to internal medicine or surgery, and sometimes even at a distance, too many radiologists have unconsciously suffered varying degrees of professional isolation and have lost contact with clinical medicine—sometimes to such an extent that they are no longer capable of examining patients. Especially in the field of malignant tumors is this a great misfortune. The radiologist should know at least as much about malignant neoplasms as his medical and surgical confrères, and the more pathology he knows the better. Because he has to deal largely with referred cases, and because many patients come to him with some sort of diagnosis already made, it is all the more important that his knowledge should enable him to confirm the diagnosis, or to modify it more or less by an independent examination. Although this may seem superfluous, it is not rare for clinicians or surgeons to overlook features of a malignant process that may alter the prognosis and treatment considerably.

It has often been my experience to see patients who were suffering from malignant conditions which were eminently amenable

to radiotherapy and who, because of improper or inadequate irradiation, had been robbed of the possibility of cure or improvement which might, and in some cases surely would, have followed more thorough treatment. Even when the chance of cure is slight, why throw it away? On the contrary, it is when the chance of cure is smallest that the radiologist should make the greatest effort. But even when the utmost which may be expected is a variable degree of improvement, the radiologist should strive to obtain maximum improvement in the least possible time. It is pitiful to see patients who, because of bungled treatment have been allowed to suffer for months or years from pain or other distressing symptoms which might have been relieved in a short time. Fortunately, the responsibility does not always rest on the radiologist, it frequently rests on the attending physician or surgeon who, not knowing that the symptoms might be relieved by radiotherapy, has not sought the co-operation of the radiologist until the patient's condition has become desperate.

This brings me to the main subject of this paper. When, at professional meetings, or in private conversations among radiologists the discussion turns to the treatment of a given condition, one of the most common questions asked is "what dose do you give?" meaning thereby "what quantity of roentgen rays do you give?" The frequency with which this question is asked shows that, in the mind of the average radiologist, the quantitative dose of rays is the most important factor in the treatment. Moreover, the comparative infrequency with which information on other factors is sought indicates that the quantity of rays is the all-important factor. The quality of the rays as it affects relative absorption at different levels beneath the surface is commonly passed over as of little consequence. Another factor which frequently receives insufficient consideration, and sometimes none at all, is the method or scheme of irradiation. And yet this factor is as important, and sometimes more important, than the quantitative dose of

leading. It is not the rays that select certain kinds of cells on which to exert their action. The only discrimination exercised by the rays is that of variation in penetrating power according to wave length. The word "selection" implies a conscious or active property. As a matter of fact, the only selection that enters into the action of roentgen rays on cells is the great variation in susceptibility of different species of cells. Any selective property, therefore, belongs to the cells themselves, but this is a purely passive and not an active property or quality.

As the trend toward higher and higher potentials has developed, the emphasis on penetration has become so great that other important factors are overlooked entirely or do not receive the degree of attention which they deserve. I refer particularly to the factor of absorption and to another factor which will be mentioned presently.

In this country the large amount of publicity given to technical and scientific developments in general, and to high voltage generators of roentgen rays in particular, has misled non-specialized physicians and the public into believing that the secret of curing cancer lies in the use of rays generated at higher and higher potentials, and that the higher the voltage at which an "x-ray machine" is capable of operating, the better *must be* the results. In fact, this public impression has become so widespread that patients often ask the radiologist what is the strength of his machine. Sometimes this impression has arisen from the unwise statement of a radiologic competitor that "Dr —'s machine is not strong enough." Of course, few patients know anything about the subject, except what they may have read in news items or health columns of newspapers or in magazine articles. Owing to the great industrial development in this country and to a general glorification of science, the average person, whether physician or layman, has become a worshipper of power. The size of the country, the tremendous scale of commercial or financial transactions, of industrial operations, of engineering under-

takings, and even the fantastic cost of government, have caused the average American to lose his sense of proportion. Unconsciously, size and power have come to outweigh everything else in the public mind.

To the radiologist, apparatus designed to generate roentgen rays is a tool which enables him to produce certain therapeutic effects. To be sure, the quality of that tool is an important factor in the results which he may be able to obtain, but the power of the apparatus in terms of voltage is only one of several qualities which it must possess if the radiologist is to perform high-grade work. A still more important factor in the quality of the radiologist's work has nothing to do with the power of his apparatus, or indeed with the apparatus at all. This factor is the training and skill of the radiologist himself. While high-grade tools are important, the quality of any kind of work depends more on the skill of the worker than on the quality of his tools. If the same tools were given to ten different carpenters, one, who through special aptitude, training and experience has developed exceptional skill, can turn out work far superior to that produced by the other nine. The same is true of radiologists.

The average quality of radiotherapy as it is carried on throughout the country is not as high as it might be, and sometimes it is distinctly low. The quality of the work done by some therapeutic radiologists is mediocre for a number of reasons. Until recent years the emphasis in radiology has been on diagnosis, and many radiologists have given most or all of their time and attention to roentgen diagnosis. The therapeutic aspects of radiology either have been neglected altogether or have received little attention. Owing to the apparently limited field of radiology during the early years of its development, many of the pioneers had no time for treatment, they were too busy making a reputation in the diagnostic field, and their pupils usually followed their example. As a consequence, many roentgenologists in practice to-day

common center The beam of rays should be directed so that the central axis of the beam will be perpendicular to the center of each of the four fields The posterior aspect of the abdomen should be divided into four corresponding fields When, as in lymphoblastoma, the aim should be to concentrate the rays on the nodes on each side of the aorta and vena cava and along the spine, the several beams should be directed more sharply inward, so that the beams from the two sides converge from front and back on the structures along the spine and immediately in front of it

When the patient is suffering from metastasis to the para-aortic nodes, secondary to carcinoma of the testis, bladder, prostate gland, uterus, ovary, or rectum, the same arrangement should be employed, but the dose per field, and hence the total dose, should be increased as much as possible This can be done to best advantage by fractional irradiation, with small daily doses continued for from 30 to 50 days

When the therapeutic problem consists in delivering to a malignant tumor involving the upper end of the humerus a large total dose of rays, and at the same time to provide for uniform irradiation, the region of the shoulder can be divided into four or six fields, the dividing line between the upper and lower fields passing transversely or obliquely through the center of the growth as determined from roentgenograms In this way the dose per field need not be extreme,

and yet, if the several beams of rays are made to converge accurately from above and below and from the anterior, posterior, and superior aspects of the shoulder, the total dose delivered to the neoplasm will be greater and the resulting regression will be more rapid than if a much larger surface dose of rays is given through only two fields

The same principle applies to tumors in the shaft of the humerus and in the bones of the lower extremity, pelvis and spine On the whole, the method of irradiation or anatomic arrangement of the treatment is more important than the quantity of rays given to any one field In fact, it is to ignorance or neglect of this principle, or to carelessness in applying it, that the mediocrity of much present-day radiotherapy is due Not infrequently, when the anatomic arrangement or method of irradiation is well planned, treatment of relatively superficial lesions with rays generated at 200 kilovolts proves less effective than treatment with rays of longer wave length

There is no doubt that the more attention is given to the anatomic plan of treatment with relation to the lesions present, the better the results which may be expected I am thoroughly convinced that this factor in radiotherapy is as important as the quantitative dose, this, however, may be arranged with reference to the time factor

rays to which the tumor may be exposed

By method or scheme of irradiation is meant the arrangement of the treatment from the standpoint of the lesion or lesions toward which the treatment is directed—in other words, the number of fields of irradiation or beams of rays, and the direction of the several beams with reference to the anatomic situation and extent of the pathologic process. For example, when the patient has a malignant neoplasm in the mediastinum, a common practice is to arrange the treatment through an anterior and a posterior field, or only through a single anterior field. Even when the malignant process has a considerable degree of radiosensitiveness, the usual result under these circumstances is only slight and transient improvement, or none at all. This method of irradiation is selected because it is thought to represent the method whereby the best possible results can be obtained. And yet this is far from true. Instead of only one anterior field, or instead of an anterior and a corresponding posterior field, more uniform irradiation of an intrathoracic, and especially a mediastinal, tumor can be obtained by arranging the treatment through two anterior and two posterior fields, with the four beams of rays converging as accurately as possible on the mediastinal region in which the growth is situated. When the neoplasm is clearly unilateral, such as is the case with an endothelioma of bone arising from a rib, from three to six beams of rays can be directed on it from the anterior, lateral, and posterior aspects of the corresponding half of the thorax. Of course, the larger the number of fields of irradiation, the more care is necessary to direct the several beams accurately and to arrange the quantitative dose per field and the total dose so as not to cause irreparable injury to adjacent normal structures. The reason for three large instead of six smaller fields in some cases is that, when the tumor is comparatively small, large beams of rays are more certain to include the malignant process in its entirety. With small fields, accurate direction of the

beams becomes more difficult. The larger the neoplasms, the greater the number of fields through which the treatment can be given with greatest effectiveness.

It matters not whether the treatment is given within a few days (from three to twelve) or whether a smaller fraction of dosage is given daily or twice a day for a long time (from 15 to 60 days), the importance of the method of irradiation (anatomic arrangement) is just as great in the one case as in the other.

Another patient may be referred with a clear diagnosis of actinomycosis of the abdominal structures, of tuberculous peritonitis, or of lymphoblastoma affecting the retroperitoneal nodes. In such cases the secret of therapeutic success does not lie in the largest possible total dose of rays. On the contrary, too large a total dose would tend to defeat the purpose of the treatment. The main requirement is uniform exposure of the abdominal structures or of the abdominal nodes to a moderate quantity of rays or at least to a sub-erythema dose. In the first two of the three conditions mentioned the quantitative surface dose per field should not exceed 75 per cent of the tolerance dose. Doses larger than this may cause enough reactive inflammation to increase the activity of the disease. In treating lymphoblastoma, also, the quantitative dose should not be sufficient to induce erythema of the overlying skin but should be higher than in the case of the two other diseases (85–90 per cent). To employ too large a dose is to risk producing, in the connective tissue of the hyperplastic lymph nodes, an inflammatory reaction which would cause the nodes to become less sensitive to irradiation in the future. The increased resistance to irradiation observed by some radiologists is largely due to excessive dosage.

In order to irradiate the abdominal structures as uniformly as possible, the best method is to divide the anterior half of this part of the trunk, from the level of the xiphoid cartilage to the pubic region and from one mid-axillary line to the other, into four fields of equal size, with the navel as the

buds is more directly related to the mitogenetic effect than an increase in volume. The sources of radiation or the "senders" which we investigated may be divided into three categories: biological, chemical, and physical. The biological materials included active-growing suspensions of yeast or bacteria, onion roots and pulp, blood, freshly incised rat carcinomas without necrosis, and tumors removed at operation and suspected of being malignant. Three chemical sources were used: the peptic digestion of fibrin, the reaction between potassium permanganate and hydrogen peroxide, and the oxidation of tissue extracts or of yeast suspensions. These two classes of "senders" were tested with both the yeast detector and the photo-electric counter tube.

In order to determine the effect on yeast cultures of artificial ultra-violet light from controllable sources, we used a water-cooled Kromayer quartz lamp and also a Westinghouse ultra-violet lamp with Slack window. Studies were made with the total radiation, with monochromatic radiation, and with radiation interrupted by a revolving disk. In addition, we employed crystalline sodium chloride which had previously been exposed to roentgen rays (3). This salt, when irradiated, will subsequently give off weak ultra-violet radiation with an emission maximum at 2,450 Å, in the presence of visible light. The intensity of this radiation, which can easily be detected with the photo-electric Geiger-Müller counter, can be made to approach the low intensities claimed for the mitogenetic radiation. Cultures of yeast were exposed to the ultra-violet emission from irradiated salt crystals.

The results of our investigations with both physical and biological detector methods may be stated briefly. The counts obtained with the photo electric counter exposed to biological or chemical materials as previously described did not fall outside the limits of fluctuation in the control of background counts. In the experiments with yeast, an apparent increase in growth rate was noted occasion-

ally but, for large series of observations, fell within the range of variation in the control cultures. All in all, our experiments thus far failed to confirm the observations concerning the existence of mitogenetic radiation as reported by Gurwitsch and his co-workers.

PART II — (HANS BARTH)

After publication of the investigations of Rajewsky (4) and Frank and Rodionow (5) on the detection of mitogenetic radiation with physical light counters, I repeated their experiments at the Physical Institute of the University of Munich, using an apparatus which was essentially the same as that employed by Frank and Rodionow. At first I used as "senders" the chemical reaction between ferrosulphate and potassium bichromate and also several albumin reactions such as Gurwitsch had suggested. After a few preliminary experiments on the construction of sufficiently sensitive counter tubes, I was able to report (6, 7) definite and reproducible effects of various "senders" upon the counters. Control experiments showed that the effects were produced by ultra-violet light and not by any other influence upon the measuring apparatus.

It was of interest at that stage to continue these experiments in closer co-operation with a biologist. This was made possible by the kind invitation of A. Gurwitsch to work in his laboratory in Leningrad. Then the experiments were extended to include three other possible sources of radiation, namely, carcinoma in Ringer glucose, aluminum dissolved in hydrochloric acid, and glucose as a secondary radiator.

The detailed results of these experiments have been reported (8), therefore, only a short résumé will be given now. All of the "senders" were tested in a large series of experiments and were found to produce definite and positive effects which lay outside the statistical error. The cathodes used in the counters were made of aluminum, copper, or iodine compounds of copper and silver.

STUDIES ON THE PROBLEM OF MITOGENETIC RADIATION¹

By OTTO GLASSER, PH D , and HANS BARTH, PH D , Cleveland, Ohio

Department of Biophysics, Cleveland Clinic Foundation

PART I —(OTTO GLASSER)

EXPERIMENTS on mitogenetic or Gurwitsch radiation have been conducted in the Department of Biophysics of the Cleveland Clinic Foundation for the past seven years. A study of the whole problem of this type of radiation and a discussion of some of our results were published recently (1,2). Our observations did not confirm those reported by Gurwitsch and his co-workers. Fortunately, Hans Barth, who has obtained positive results in direct collaboration with Gurwitsch, is now continuing his studies on the mitogenetic radiation in our laboratory and will present his observations in the second part of this paper.

The chief problem concerning mitogenetic radiation primarily consists in discovering or devising reliable methods for detecting its presence. We have worked with both physical and biological detectors. Naturally, it is desirable to utilize physical methods and we, therefore, first employed a photographic method, then the photo-electric Geiger Muller counter tube. We soon abandoned the photographic method as being unreliable. Our Geiger counter tube method has been described in a previous communication (1). In brief, it consists of a cylindrical tube connected through a multi-stage vacuum tube amplifier to a magnetic counter, a loud speaker, and a ticker tape recorder. The plate materials were selected for sensitivity to short ultra-violet radiation and have included Cd, Zn, Sn, Au, Ni, and Pt. The "senders," which are supposed to emit mitogenetic radiation, were placed over the quartz window of the counter tube in quartz vessels. Control counts were made by interposing a glass window during alter-

nate periods, all other conditions remaining the same.

Since biological detectors have been employed by many investigators of mitogenetic radiation, we also conducted experiments with yeast as a biologic detector at the same time that we were employing the photo-electric counter tube. At first we used cultures of *Saccharomyces cerevisiae* and *S. ellipsoideus* in Sabouraud, Williams', and beer-wort media. Day-old cultures of yeast in quartz and glass test tubes were exposed to various "senders." After incubation overnight at 28° C, the volume of yeast was determined by centrifugation in mycetocrit tubes. Counts made with a hemacytometer supplemented the volume determination. Various cell concentrations were employed for exposure in an effort to determine the optimum stage of culture development.

About two years ago, we revised our yeast method following the receipt of two strains of yeast from the laboratories of Gurwitsch, in Leningrad. Cultures of the yeast were prepared on beer-wort-agar or in liquid beer-wort in strict conformity with the procedures Gurwitsch outlined. Determinations on liquid cultures were made by centrifugation five or six hours after exposure. The agar beer-wort cultures were homogeneous at the time of exposure and could be detected only microscopically. After a period of incubation not exceeding two hours, the yeast was gently removed with a loop, fixed on a glass slide, and stained with methylene blue. The percentage of small buds was then counted in groups of one thousand unselected cells.

In the experiments with yeast, we found the mycetocrit centrifugation method less subject to personal error than the bud-counting method. However, the Russian workers emphasize that an increase in

¹ Read at the Fifth International Congress of Radiology, Chicago, Sept 13-17 1937.

made with each counter, using the reaction between ferrosulphate and potassium bichromate, according to Braunstein and Pototzky. The sensitivities of those counters which showed definite effects with the

test those radiations of wave lengths up to 2,450 Å, which have been observed by various biologists. This probably explains many difficulties which have been encountered in previous intensity measurements

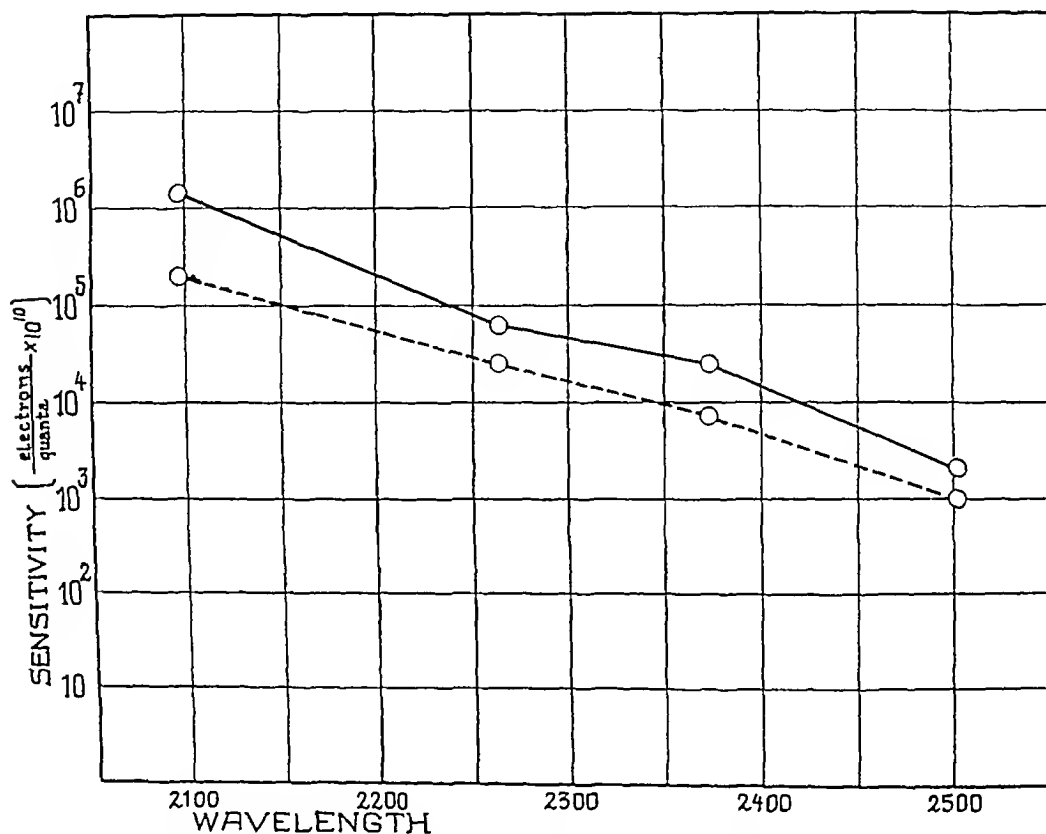


Fig 2 Sensitivity of a 'mitogenetically sensitive' and an insensitive counter tube for various wave lengths

chemical reaction (as shown in the unbroken lines in the figure) lie considerably above the counters (indicated by broken lines), showing none or only doubtful effects with the chemical reactions.

Furthermore, it can be seen that, at about 2,100 Å, the sensitivities of our good counters are almost identical. For longer wave lengths, however, the differences vary to such an extent that they also would have appeared clearly in the experiments with the chemical reactions had such longer wave lengths been present. Since all effects we obtained with the chemical reaction are between 20 and 30 per cent, we must conclude that above 2,200 Å, our

which were made on the supposition that the counters were sensitive up to 2,500 Å.

I also made preliminary attempts to measure these intensities in absolute units. Without discussing the details of the technic used, I should like to present the results (Fig 2). We measured again a "mitogenetically sensitive" and an insensitive counter and the same variation in sensitivity appeared again in measurements with an artificial source of radiation. It is about tenfold.

The results of the experiments with the chemical reaction together with the sensitivities for 2,100 Å are shown in Table I. The sensitive counter registered 0.5 count

Similarly, large series of control experiments were carried out, such as interposing quartz and glass between the radiator and the counter, testing with one or the other component of the chemical reaction

the decrease of the light sensitivity of the counter, there was also a decrease in its indication of the mitogenetic effect. Clean aluminum or copper cathodes oxidize in air, therefore, they could be used for only

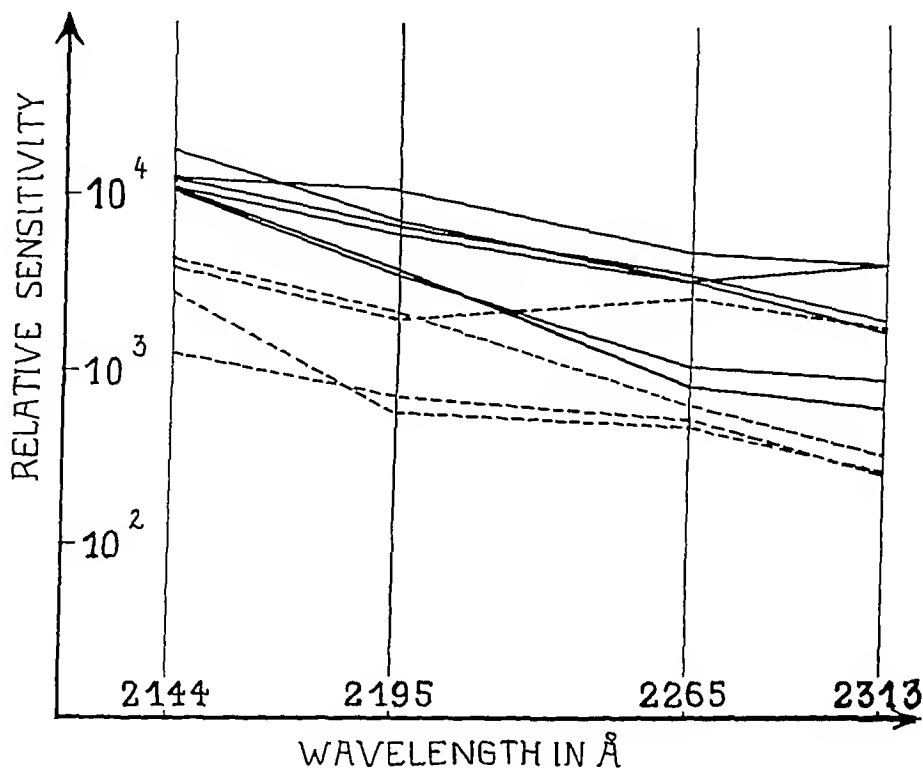


Fig 1 Relative sensitivities of ten counter tubes for various wave lengths

only, or by replacing the chemical solutions by water. Exceptionally large variations were made in the experiments with glucose, and here the effects of the primary radiation sources could be shown even at large distances. The results of these control experiments also showed that the observed effects must have been due only to ultra-violet light and not to any other effects upon the measuring apparatus such as static electrical charges or vapors from the preparations used.

In addition to these experiments an attempt was made to obtain further information concerning the photo-electric properties of our counters. The results have not been published and will be discussed in brief at this time. In our first experiments we had observed that, in accordance with

a few hours when the counters contained air but, when the counters were filled with hydrogen or argon, they could be used for as long as two weeks.

In order to make satisfactory comparisons of the sensitivity of our counters toward mitogenetic as well as artificial sources of radiation, we constructed a special apparatus consisting of a quartz double monochrometer and a small but extremely constant cadmium spark. A large series of comparative experiments was carried out last year by Philippow (9). Figure 1 shows a series of his measurements on ten counters of identical construction with copper or aluminum cathodes. The ordinates represent relative sensitivities for the wave lengths 2,144, 2,195, 2,265, 2,313 Å. In addition, an experiment was

must show whether this is correct or whether other unknown factors play an important rôle

and Mr I E Beasley, who have carried out a great many of the experiments

CONCLUSIONS

Since numerous investigators have arrived at contradictory results concerning the existence of the mitogenetic radiation, we suggest that a thorough study of both the measuring methods and the character of the radiation sources be carried out by direct collaboration of various laboratories. We are at present attempting to make a direct comparison of measuring methods based on the work presented above and we hope to arrive in this manner at some definite conclusion in regard to the problem of mitogenetic radiation.

The authors wish to express their appreciation to Professor A. Gurwitsch, of Leningrad, for his continued interest in these investigations, and to Miss Margaret Schott,

REFERENCES

- (1) GLASSER, O. The Detection of Mitogenetic Radiation. *Atti del I Congr Internat di Elettro-Radio-Biologia*. Venezia, September 1934.
- (2) GLASSER, O., and SCHOTT, M. Mitogenetic Radiation, Chapt 29. *The Phenomena of Life*, George C. Crile, Norton, New York, 1936.
- (3) GLASSER, O., and BEASLEY, I. E. The Release of Ultra-violet Radiation from Roentgenized Substances by Visible Light. *Am Jour Roentgenol and Rad Ther* September, 1936 36, 381-383.
- (4) RAJEWSKY, B. Zur Frage des Nachweises der Gurwitschstrahlung. *Zehn Jahre Forschung auf dem physik-med Grenzgebiet*. Thieme Leipzig, 1930 (p 244).
- (5) FRANK, G., and RODIONOW, S. Physikalische Untersuchungen mitogenetischer Strahlung der Muskeln und einiger Oxydationsmodelle. *Biochem Ztschr* 1932, 249, 323-343.
- (6) GERLACH, W. Physikalisches zum Problem der mitogenetischen Strahlung. *Sitzungsber der Gesellschaft f Morphologie und Physiologie*, München 1933 42, 1.
- (7) BARTH, H. Versuche zum physikalischen Nachweis von mitogenetischer Strahlung. *Archiv des Sciences Biologiques Med Exp*, Leningrad, 1934 35, 29.
- (8) Idem. Physikalische Versuche zum Problem der mitogenetischen Strahlung. *Biochem Ztschr*, 1936, 285, 311-339.
- (9) PHILIPPOV. Zur Frage der Messung von mitogenetischer Strahlung mit dem photoelektrischen Zähler. *Dissertation*. Leningrad, 1937.

ference compared to the zero reading of the second counter lies outside the error. A threefold variation of the control experiments always led to exactly the same results.

The problem of intensity still seems to present certain difficulties in regard to the explanation of our experiments. For instance, the intensity measured for the mitogenetic radiators was found to be at

TABLE I

Sensitivity to the chemical reaction $K_2Cr_2O_7 + FeSO_4$, and to ultraviolet light

Nr.	Total Number of Counts	Minutes	Counts in 1 Minute with Effect	without Eff	Difference	Sensitivity for light (2100 Å)
I {	a 620	220	3.1	2.6		
	b 600	220	3.1	2.5		
	c 800	269	3.3	2.7		
Total	1620	584	3.12	2.63	0.49 ± 0.13	$14 \cdot 10^{-4}$
II {	a 800	169	4.8	4.7		
	b 600	140	4.3	4.3		
	c 600	138	4.4	4.3		
Total	2000	447	4.49	4.43	0.06 ± 0.18	$21 \cdot 10^{-5}$

The sensitivity of the good counter amounts to about 10^4 quanta per electron at 2,100 Å. This corresponds to a radiation energy for the reaction of about 10^3 quanta per square centimeter and second, if we assume that only light near this wave length has acted upon the counter.

It was thus shown that the mitogenetic radiators affect only those counters which have the highest ultra-violet sensitivity obtainable. Our experiments with mitogenetic radiation sources gave a complete confirmation of the results which Gurwitsch and his collaborators obtained in similar experiments with biologic detectors. In our experiments, the influence of glass and quartz was identical with that obtained with ultra-violet light.

the lower limit of the intensity needed to explain many biological results. On the other hand, the physical experiments which produced negative results show that the intensity of the radiation probably cannot be very much greater, otherwise the proof of its existence would not be particularly difficult. Yet, according to the results obtained so far with such radiators, one must expect that intensities of different radiation sources vary widely among themselves.

One can easily assume that this discrepancy is only an apparent one and that its causes can be explained by the almost complete lack of quantitative measurements and of sufficiently accurate calibrations of counters. Further experiments

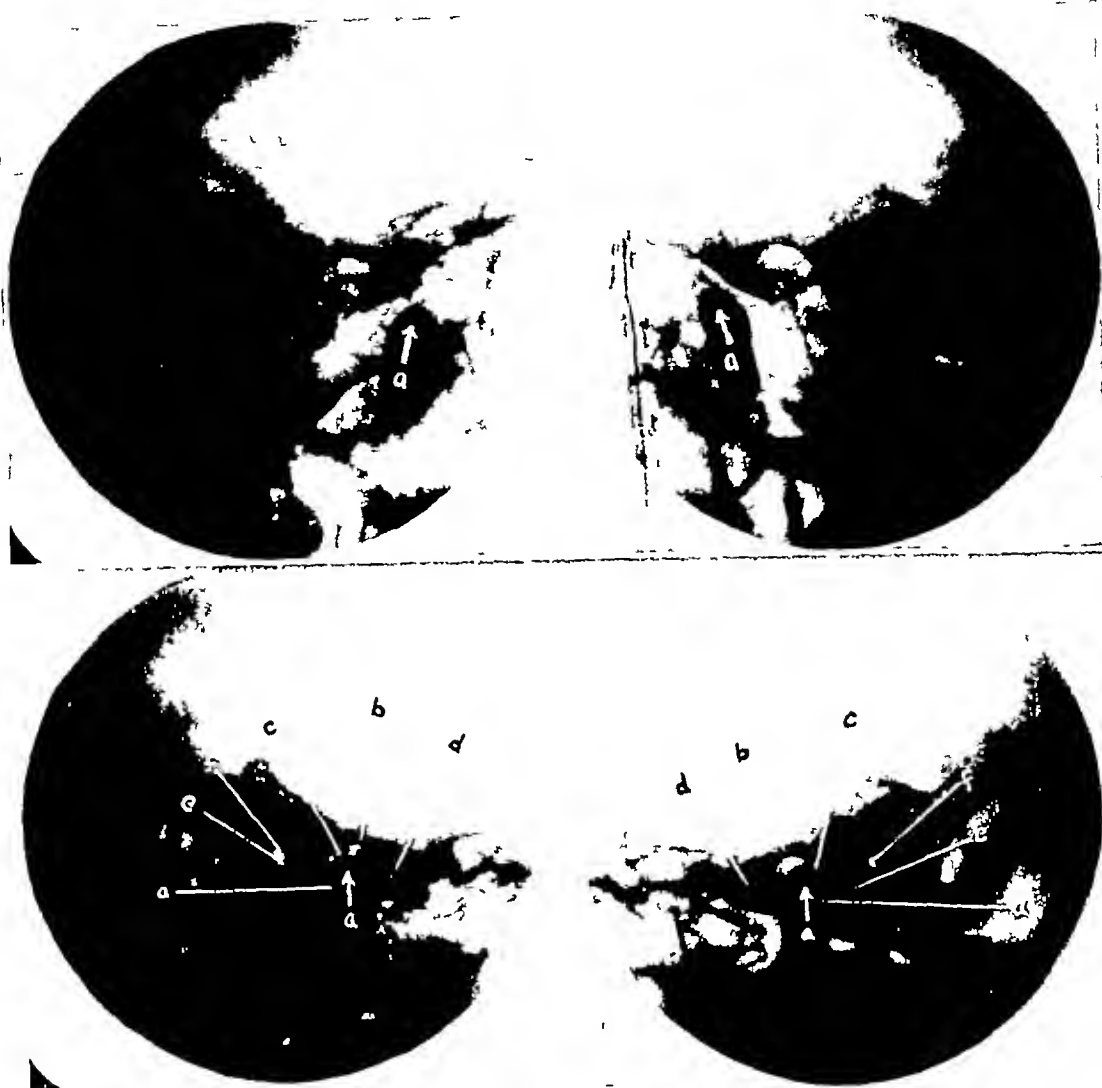


Fig 3 (above) Normal mandibular joint A Condyle during the open position of the jaw

Fig 4 (below) Normal mandibular joint A, Condyle at rest in the closed position of the jaw, B, The glenoid fossa C, Meniscus D Articular tubercle, E, Tympanic plate, F External auditory meatus

effects are noted, irritation of sensory nerves within the capsule produces trismus of the jaw muscles, and uneven pressure is exerted upon the meniscus and other jaw structures

The auriculo-temporal nerve passing intimate to the joint is subjected to pressure, reflex neuralgias appear in other branches of the fifth nerve and burning pain is referred deeply about the ear, to the vertex, about the eye, and along the border of the tongue throughout the area supplied by the lingual nerve (2) These symptoms do

not long remain mild The patient seeks relief for supposed disease of the eyes and sinuses, and when burning of the tongue is established, lives in constant dread of cancer of the tongue (3) In a large percentage of burning tongue cases, inhibition of saliva occurs as a result of some complex effect of the combined irritation of the chorda tympani and auriculo-temporal nerves, both being within range of the aberrant condyle Symptoms of catarrhal deafness are found in widely overclosed, edentulous cases, the effect of wrinkling and

X-RAY STUDY IN RELATION TO THE MANDIBULAR JOINT SYNDROME¹

By EDWIN C. ERNST, M.D., and JAMES B. COSTEN, M.D., *St. Louis, Missouri*

From the Departments of Radiology of the Barnard Free Skin and Cancer and DePaul Hospitals, and the Department of Otolaryngology, Washington University School of Medicine

THE object of this presentation is to correlate the roentgenological findings of temporomandibular joint pathology other than acute infections, fractures, dislocations, specific diseases, malignant lesions, or acute trauma changes

glenoid fossa varies widely with the individual. However, in the normal joint, with the condyle at rest in the closed position of the jaw, the space between its surface and the tympanic plate or the glenoid fossa, is uniform, slightly narrower

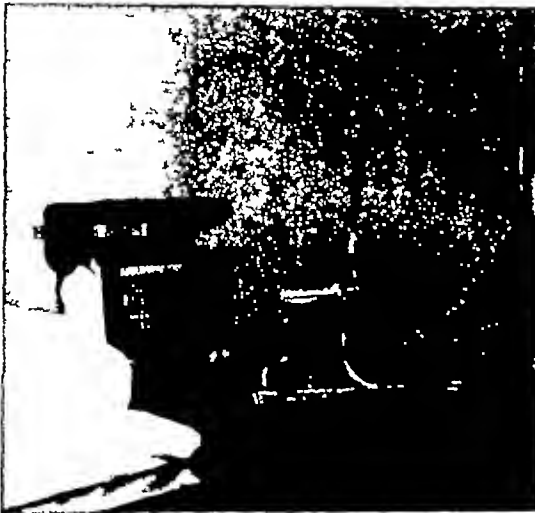


Fig 1

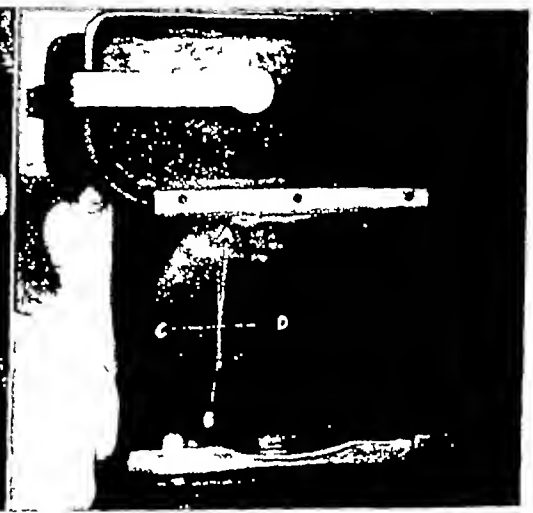


Fig 2

Fig 1 The apparatus employed for the fixation of the head in the reclining position on a horizontal table (Bullitt), the beam angles having been modified to meet the needs for the examination of both temporomandibular joints at known fixed and reproducible angles in relation to the auditory canal landmarks and the base line of the skull. Throughout the examination the head remains fixed but the tube may be shifted to the right and left sides of the skull either for the single bilateral or stereoscopic exposures.

Fig 2 Close up view of the cross marks on the transparent window in relation to the auditory canal and the base line of the skull. A-B Base line position inclined 5° as shown above. C-D Horizontal cross line through external auditory meatus.

The disposition of structures which make up the temporomandibular joint, the condyle, the meniscus, the glenoid fossa, the forward limiting articular tubercle, accounts for the regular spacing of bone outlines which is purely relative. The exact distance between the surface of the condyle and any sector of the curve of the

next to the tubercle. Even in the open position the same space appears between the condyle and tubercle, to account for the intervening meniscus (1).

The ultimate position of the condyles being determined by occlusion during physiologic rest of the jaw, malocclusion of the teeth, or loss of the teeth initiate the first changes toward pathologic reaction within the joint. With the first irregular movement of the condyles, long before pain

¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

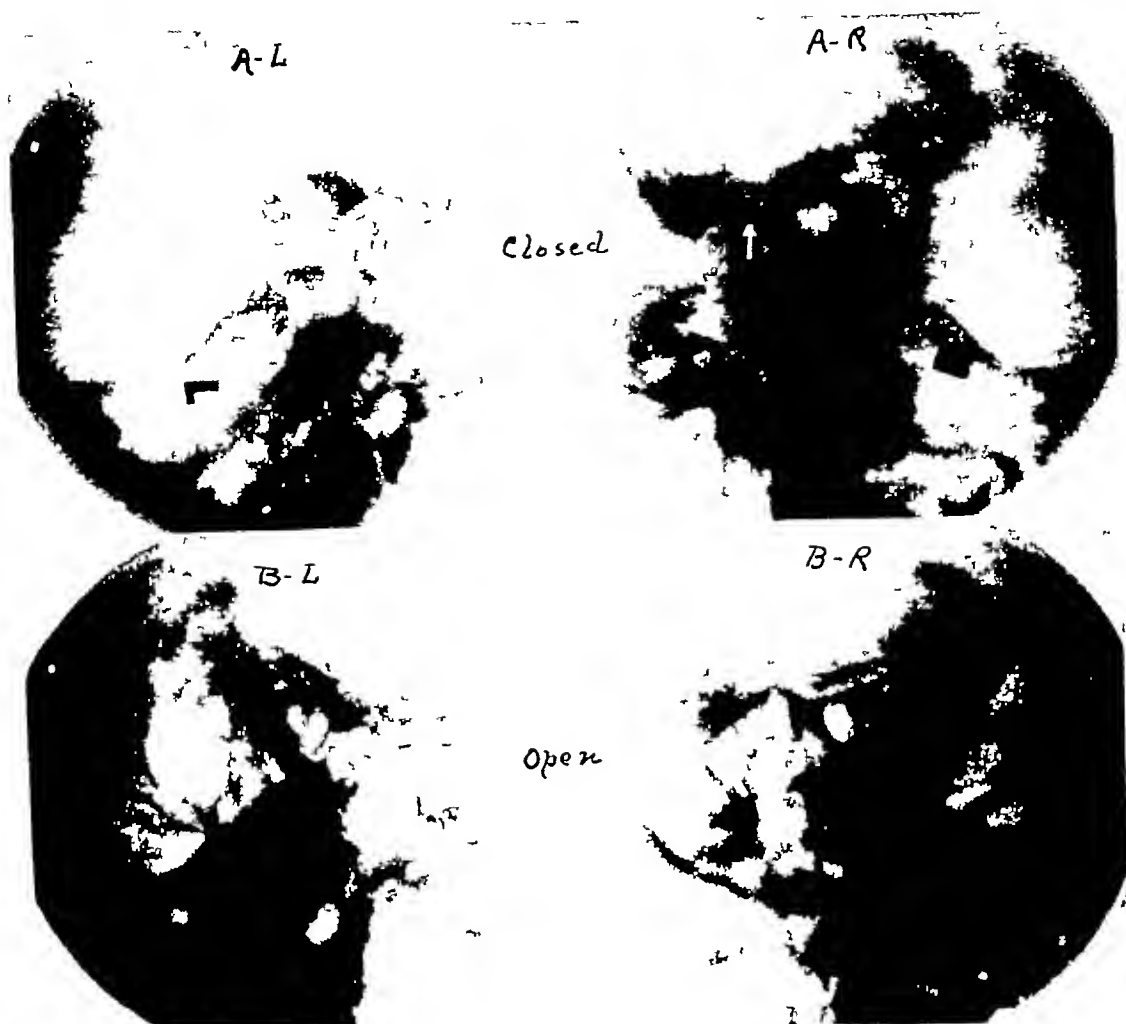


Fig 6 The mandibular joint with arthritic changes to the extent of partial or complete ankylosis Case 2 Mr K aged 35 *Clinical Symptomatology*—Crackling noise and sharp boring pain within the left ear for past two years and stiffness of jaw movements since forceful reduction procedure for malocclusion at the age of 12 Pain radiates to zone about the left eye *Roentgenological Findings*—Hazy joint outlines increased on the left face of condyle flattened glenoid fossa angulated by erosion joint space extremely narrow *Treatment*—Full mouth reconstruction by thin overlays on natural teeth extend vertical molar dimension on left A-L Closed position, left mandibular joint A-R, Closed right mandibular joint, B-L Open left mandibular joint B-R Open right mandibular joint

poro-mandibular joint are indispensable toward an early and correct diagnosis and of equal value to the subsequent and proper treatment thereof. The roentgenologic difficulties of satisfactorily outlining the joint relationships and movements are many but nevertheless remain largely anatomical problems. The many superimposed bone structures further handicap the proper projection of the mandibular joint upon the x-ray film. Valuable contributions have been presented in this direction by National and Continental ob-

servers, including Sproull (6), Higley (7), Bishop (8), Lindblom (9), Altschul (10), Riesner (11), and many others.

The various technical x-ray approaches relative to the mandibular joint studies include a variety of anteroposterior, oblique, and lateral examinations. A true exposure of the relationships of the articulating surface of the temporo-mandibular joint is not obtainable in the usual routine inferior lateral view of the ramus of the lower jaw. In addition to other disadvantages, the extreme oblique methods of ex-

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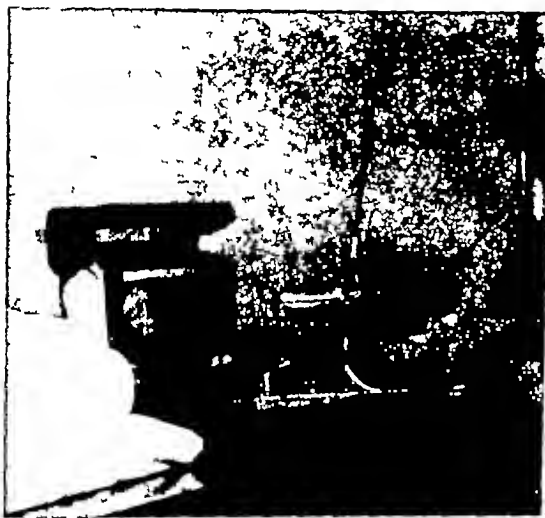


Fig 1

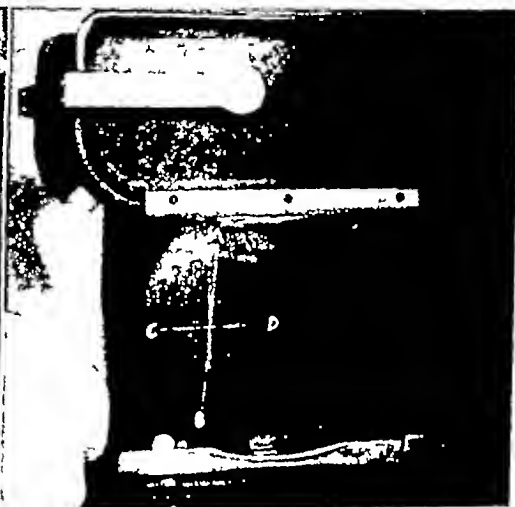


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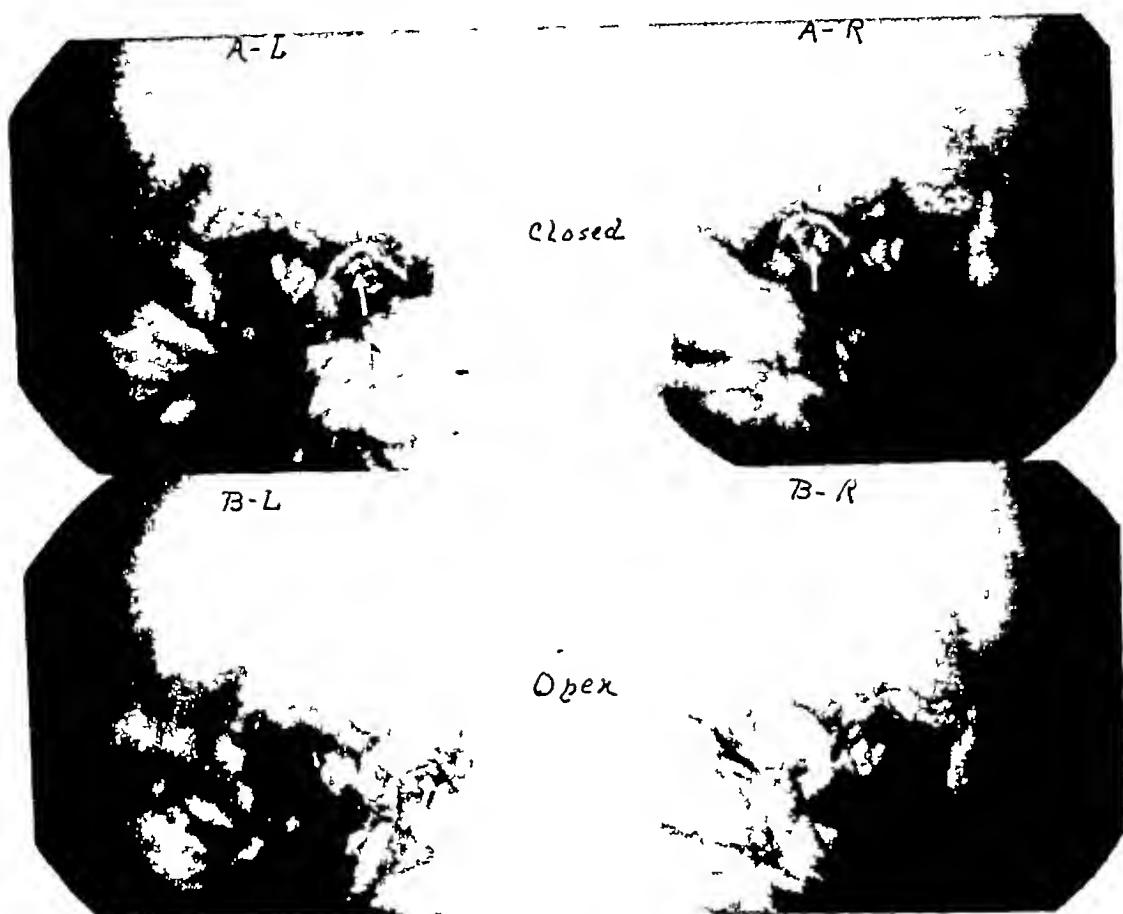


Fig 8 Erosion and flattening of the face of the condyle and the posterior aspect of the tubercle
 Case 4 Mrs S N aged 55 *Clinical Symptomatology*—Pain deep within and about the ears for from 15 to 20 years appeared on left side then shifted to right two years ago it extended to a peri-oral burning or dryness Extensive studies ruled out any blood dyscrasia or neurological lesion *Roentgenological Finding*—Erosion and flattening of the face of the condyles with co-ordinate angulation of the glenoid fossa more marked on the left, limitation of excursion of condyles in open position *Treatment*—Treatment dentures to replace absent molar teeth extending vertical dimension slightly more on the left than the right side A L, Closed position left mandibular joint A-R, Closed right mandibular joint, B L Open left mandibular joint B R Open right mandibular joint

tubercle The x-ray beam on this apparatus should be checked so that the projection is centered upon the opposite meatus at the cross-lines on the celluloid window, the x-ray tube being angulated 20° superior to the meatus and toward the feet through the posterior area of the temporal bone The apparatus (Fig 1), described by Bullitt (12) for stereoscopic mastoid examinations may be modified for this purpose as described above, and thus serve a dual purpose The upper bracket of the tube position is the preferred procedure in order to obtain the desired diagnostic projection

upon the radiogram The head or auditory meatus landmark should be half an inch lower than the usual mastoid position along the base line or below the cross-marks as observed at the celluloid window (Fig 2) when the mandibular joint is examined All of these angles pertain to the patient in a recumbent position

The head is easily raised or lowered by means of an elevating table so as to facilitate the localization of the respective auditory canals to the cross-marks on the vertical windows This assures the accurate reduplication of subsequent exposures



Fig 5 Lax temporo-mandibular joint Case 1, Mrs B, aged 54 *Clinical Symptomatology*—Grinding noises in ears and slipping of jaw backward on closure of the jaw for past three years Taste disturbance "copper" taste, and dryness of mouth at all times Intermittent impairment of hearing, but hearing tests showed only very mild degree of catarrhal deafness Edentulous mouth for ten years *Roentgenological Findings*—Extreme anterior excursion of the condyle to the tubercle normal position and absence of erosion of the condyles within the glenoid fossa *Treatment*—Dental plates replaced opening the bite. A L Closed position, left mandibular joint A-R Closed right mandibular joint, B-L, Open left mandibular joint B-R Open right mandibular joint

compression of soft tissue structures bordering the Eustachian tubes Tinnitus, such as low buzzing common to catarrhal deafness, or snapping and grating from uneven destruction of the meniscus, is commonly present (2) The series of changes, encouraged by gradual loosening of the capsule, is complicated by voluntary efforts to adapt the jaw comfortably to chewing movement The meniscus becomes thinner at its thinnest spot where the face of the condyle impinges upon the tubercle—Axhausen (4), Steinhardt (5)—and the peak of the trismus occurring here,

perforation ensues The anterior aspect of the condyle and the posterior surface of the tubercle undergo erosion Inflammatory reaction is constantly present, exaggerates the trismus, accounts for the tenderness to palpation of the joints, and roentgenologically increased density of the capsule is the usual finding The condyle finally assumes abnormal rest positions within the glenoid fossa, commonest of which is forward against the tubercle

In view of the foregoing, it is self-evident that accurate and standardized roentgenologic methods for examining the tem-

is presented for consideration and discussion

2 All stages of pathologic change within the temporo-mandibular joint, relaxation or ankylosis, impaction of the condyle, erosion of structures, and bone destruction, may be defined by roentgen study, except mesial displacement

3 Varieties of change of the joint structures may be classified into groups, whose clinical observations, neuralgias, and ear symptoms are typical and correspond with changes seen in actual sections of the joint

4 The x-ray method described for the examination and guide to treatment of temporo-mandibular joint pathology has fulfilled in almost every respect the essential technical and practical requirements of accuracy, flexibility, and reduplication of serial exposures

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BIBLIOGRAPHY

(1) PIERSON, GEORGE A Human Anatomy, ninth ed, revised, 1930, pp 214, 215

(2) COSTEN, J B A Syndrome of Ear and Sinus Symptoms Dependent upon Disturbed Function of the Temporo-mandibular Joint Ann Otol, Rhin, and Laryngol, March 1934, 43, 1-15

(3) Idem Glossodynia Reflex Irritation from Mandibular Joint as Principal Etiological Factor Arch Otolaryng November, 1935 22, 554-564

(4) AXHAUSEN G D Das Kiefergelenkknacken und seine Behandlung Deutsche Ztschr f Chir, 1931, 232, 238-272

(5) STEINHARDT, G Zur Pathologie und Therapie des Kiefergelenkknackens Deutsche Ztschr f Chir, 1933, 241, 531-552

(6) SPROULL, JOHN Technic of Roentgen Examination of the Temporo-mandibular Articulation Am Jour Roentgenol and Rad Ther, August 1933, 30, 262-264

(7) HIGLEY, L B A New and Scientific Method of Producing Temporo-mandibular Articulation Radiograms Internat Jour Orthodontia October 1936, 22, 983-991

(8) BISHOP, PAUL A Roentgen Consideration of the Temporo-mandibular Joint Am Jour Roentgenol and Rad Ther June, 1929 21, 556-563

(9) LINDBLOM GOSTA Technic for Roentgen-photographic Registration of the Different Condyle Positions in the Temporo-mandibular Joint Tidskrift Voor Tandheelkunde, 1936, 43, 1018-1031

(10) ALTSCHUL WALTER Studies on the Temporo-mandibular Joint Am Jour Roentgenol and Rad Ther, September, 1931, 26, 452-455

(11) RIESNER SIDNEY Temporo-mandibular Articulation Its Consideration in Orthodontic Diagnosis Internat Jour Orthodontia January, 1936, 22, 1-30

(12) BULLITT J B An Apparatus for Stereoscopic Roentgenology of the Mastoids Am Jour Roentgenol and Rad Ther 1926, 15, 256, 257



Fig 7 Erosion of the meniscus with marked joint or condylar changes Case 3, Mr O aged 63 *Clinical Symptomatology* (with pain symptoms)—Tinnitus and impaired hearing involving right then left side for ten years—exaggerated when new dental plates were acquired one year ago Burning along right side of tongue during above period, with marked dryness of mouth *Roentgenological Findings*—In the closed position the condyles rest flush against the tubercle, showing evidence of perforation of the meniscus, erosion and flattening of the anterior surface of the condyles—more marked on the left open position shows slight restriction of movement of condyles *Treatment*—Dental plates replaced increasing vertical molar dimension slightly and closing incisors, thus moving condyles straight backward in their closed position A-L, Closed position left mandibular joint, A-R Closed right mandibular joint B-L Open left mandibular joint B-R Open right mandibular joint

amination unfortunately increase the problem of distortion of the joint structures. The various modified lateral views, especially those made stereoscopically, have been most helpful when the involvement is moderately well advanced. In our experience, "the method of angulating or rotating the head" to the required angle in combination with a fixed or stationary x-ray beam may frequently influence the accurate projection of the condyle and fossa and thus alter their respective relationships (7). Therefore, bilateral exposures should preferably be made with the patient's head at absolute rest and fixed

in a known position during the open and closed studies of the right and left mandibular joints.

The intersection of the base and horizontal lines on the celluloid windows (Fig 2) will serve as the centering points for localizing the respective right and left auditory canals. The head is then firmly clamped face upward. The base line of the patient's head, namely, a line through the auditory canal and external canthus, should be angulated 5° in the direction of the vertex of the skull. This latter procedure is essential for obtaining the necessary clear outlines of the fossa and articular

(b) The pathologic reactions within the respiratory bronchioles and their air sacs

sacs and of the bronchial lumen but entirely different in their pathologic appearance and in their pathogenesis



A



B



C



D

Fig 1 These reproductions are shown to illustrate the influence of aeration upon roentgen portrayal of pulmonary anatomy and that a decrease or increase of air content may be demonstrated

I A Stillborn infant with no pulmonary aeration and no pulmonary differentiation of tissues

I B Microscopic section of bronchi and arteries bound together by connective tissue and surrounded by air within the pulmonary air sacs

I C Acute emphysema in a child with a relative increase of the air content in the bases

I D Early silicosis in an adult with a decrease in the relative air content

The pathologist describes such reactions as bronchiectasis or emphysema, both producing dilation of the air

Likewise, atelectasis or cellular exudate or edema will obliterate the air spaces and cast the same roentgen

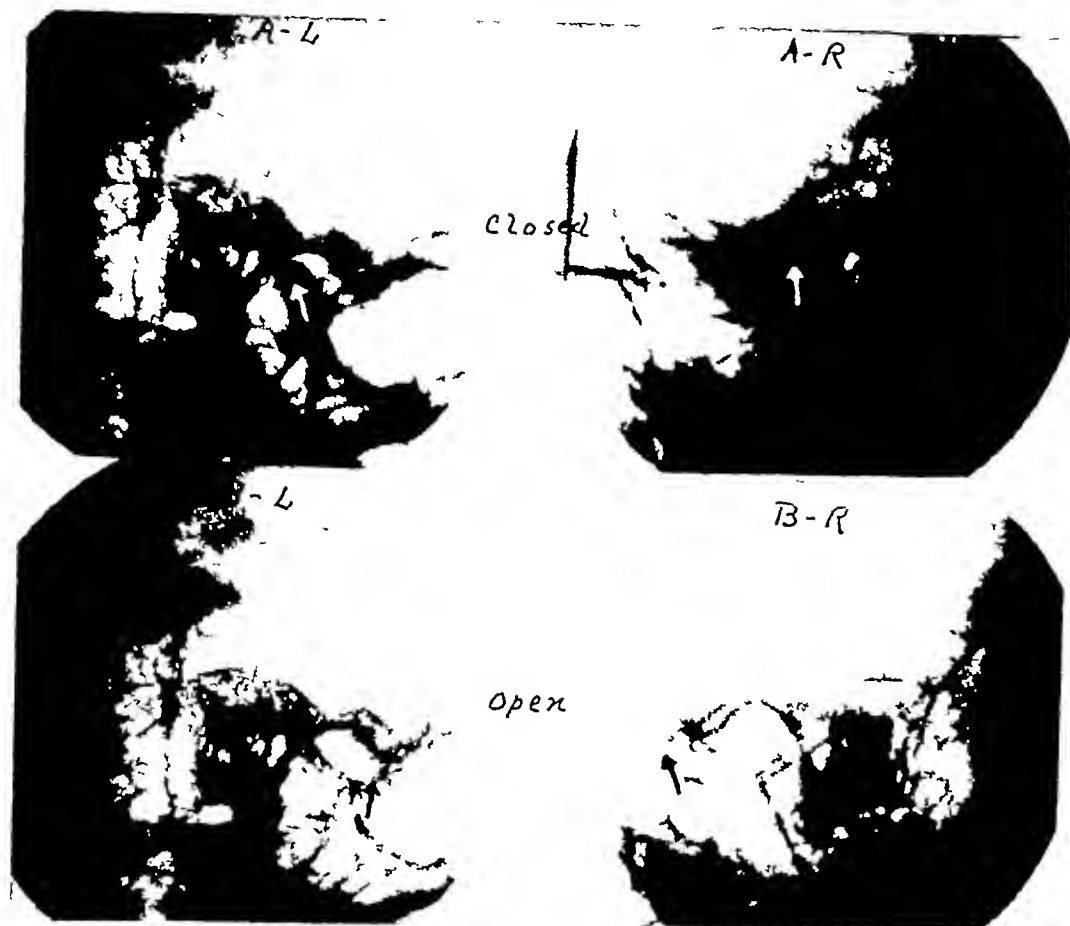


Fig 9 Destruction of the condyle and part of the meniscus (with snapping only," otherwise no early symptoms or pain) Case 5 Miss K aged 18 *Clinical Symptomatology*—Stiffness in jaw muscles for past year, relieved by massage, but persistent, and since onset the patient has had grinding noise within the left ear *Roentgenological Findings*—Some erosion of the face of left condyle, which rests backward against the tympanic plate, and shows limitation of motion in the open position the right condyle shows abnormally free excursion Complete horizontal impaction of both lower third molars, more marked on the left side *Treatment*—Extraction of impacted unerupted third molars To await a time for relief of trismus from this source before any treatment for position of the jaw A-L Closed position left mandibular joint A-R, Closed right mandibular joint, B-L, Open left mandibular joint, B-R Open right mandibular joint

of the temporo-mandibular joint structures for the necessary comparative studies of possible articulation surface and condylar marginal changes Another distinct advantage of this method is the incorporated swivel arrangement for the bilateral shifting of the tube from one side to the other at known fixed positions or projection angles which cannot be changed without taking the entire apparatus apart All of these tube angulations or shifting of the beam of x-ray in relation to the right and left mandibular joints can be accomplished without changing the position of the patient's head

during the entire examination This degree of standardization of the roentgenologic technical procedures in the examination of the temporo-mandibular joint has been most helpful, both from the diagnostic and treatment standpoint and invaluable for subsequent roentgen follow-ups

SUMMARY

1 Realizing the indispensable aid offered by x-ray studies in questionable temporo-mandibular joint involvements, this correlation of our present roentgenologic and clinical observations and findings

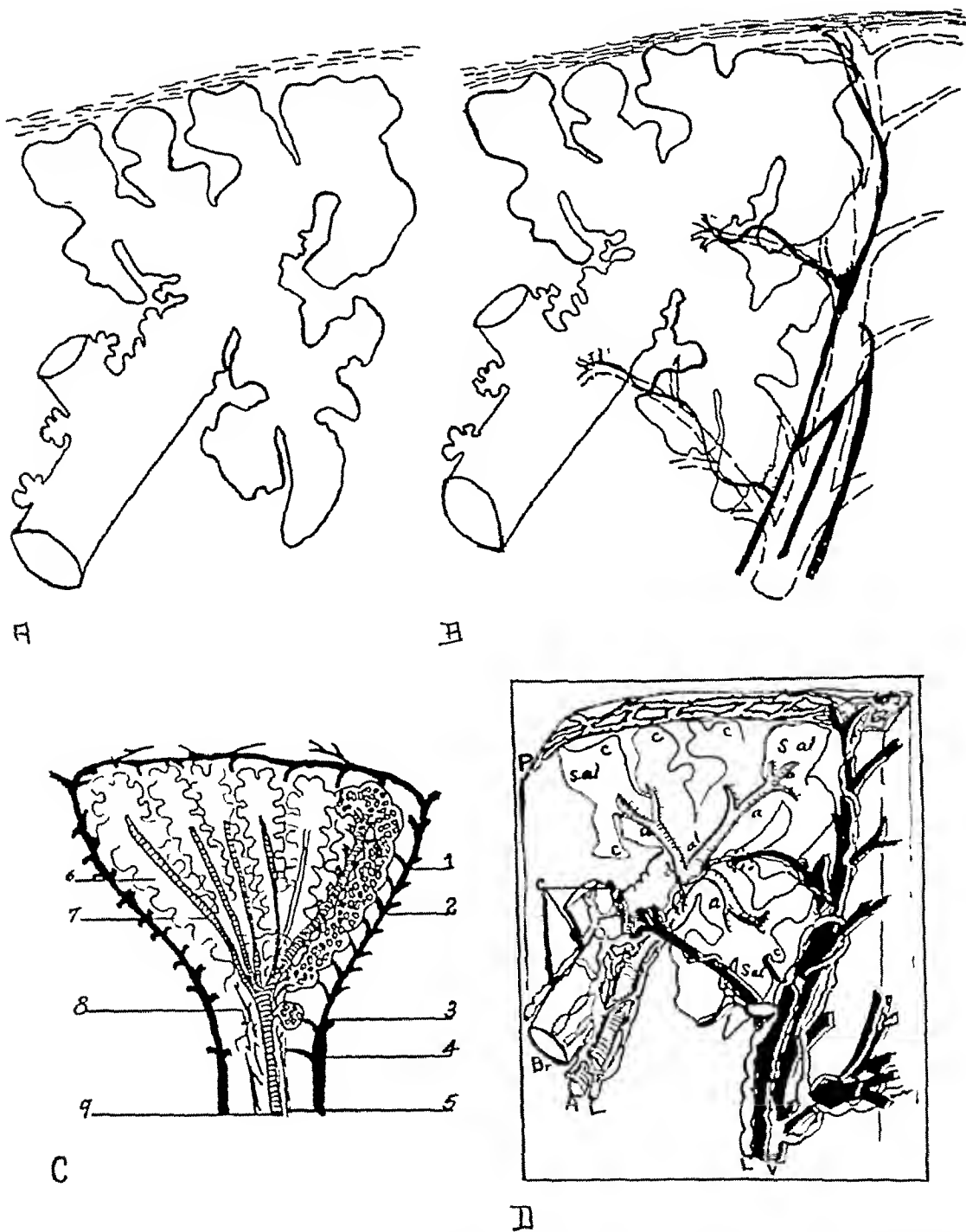


Fig. 3. Pen sketches A, B and D are from the works of William Snow Miller and C from Sauerbruch. Figures A, B and C illustrate the three systems of the primary lobule: A, the respiratory bronchus and the air sacs; B, the lymphatics; and C, the vascular system. Figure D illustrates the three systems combined to form the primary lobule.

THE PATHOLOGIC REACTIONS WITHIN THE ANATOMIC UNIT OF THE LUNG

THEIR ROENTGEN PORTRAYAL, CLASSIFICATION, AND DIAGNOSIS¹

By W WALTER WASSON, M D , *Denver, Colorado*

I The roentgen portrayal of the pathologic reactions within the anatomic units of the lung is dependent upon certain factors

- (a) Without air there is no differentiation of tissue. This is especially exemplified in the newborn infant's chest where no air has entered the lungs. The lungs cast the same shadow upon the film as any other unaerated tissue of the body. In such tissue only very dense structures such as calcified nodes or osseous structures will cast a shadow which can be differentiated from the surrounding tissue.
- (b) Any increase or decrease of the air content of the anatomic units, if of sufficient amount, can be portrayed upon the film. It must be remembered that the anatomic units are not only the aerating structures of the lung but contain the largest volume of air. The air within these units surrounds the larger and denser structures of the lungs and brings them into relief. The increased air content, such as either general or localized emphysema, is readily detected on the roentgen film, while, on the other hand, the decreased air content of the lungs is one of the early signs of silicosis or any interstitial fibrosis.
- (c) Any structural change which increases or decreases the air content of the air sacs and bronchioles, will be portrayed on the film, either by its decreased density or its increased density, providing it is surrounded by other air sacs which are well

aerated. Most of the structural changes show an increased density, as bronchopneumonia, but there are a few structural changes which show a decreased density, as bronchiectasis or localized emphysema.

- (d) In the healthy lung only the larger structures, such as the arteries and bronchi, are seen upon the film. In other words, the anatomic units consisting of the air sacs, terminal bronchioles, the smaller arteries and their capillaries, and the veins are not portrayed. Their structures are too delicate to cast any shadows, and furthermore the air content of these units tends to blot out some of the larger bronchi, arteries, and lymphatic structures, as they approach the anatomic units.

II The pathologic reactions within the anatomic units

- (a) Pathologic reactions within the anatomic units can take place in either the bronchioles and their air sacs, the arteries, veins and their capillaries, the lymphatic system, or the supporting connective tissue framework for these structures. In a lesion of sufficient size to be seen on the roentgen film, all of these anatomic structures are most certainly involved. In the usual clinical case with inflammatory reactions an involvement of one or more secondary lobules is necessary for roentgen portrayal or to produce clinical symptoms. William Snow Miller estimates that there are from 50 to 250 anatomic units in a secondary lobule and that a secondary lobule will measure from 1.5 to 2.5 centimeters in diameter.

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati Nov 30-Dec 4 1936

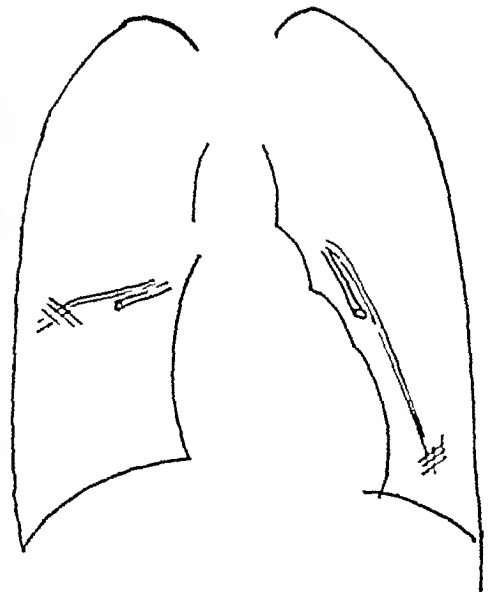
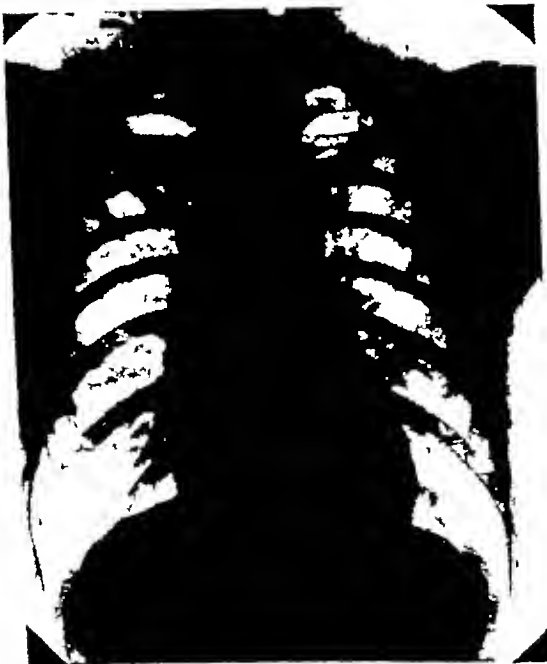
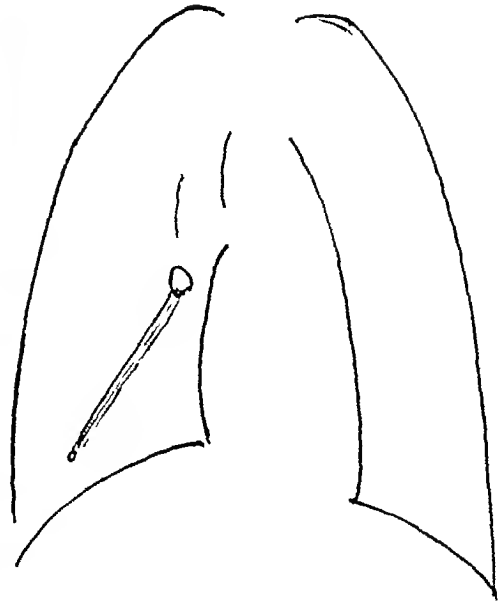
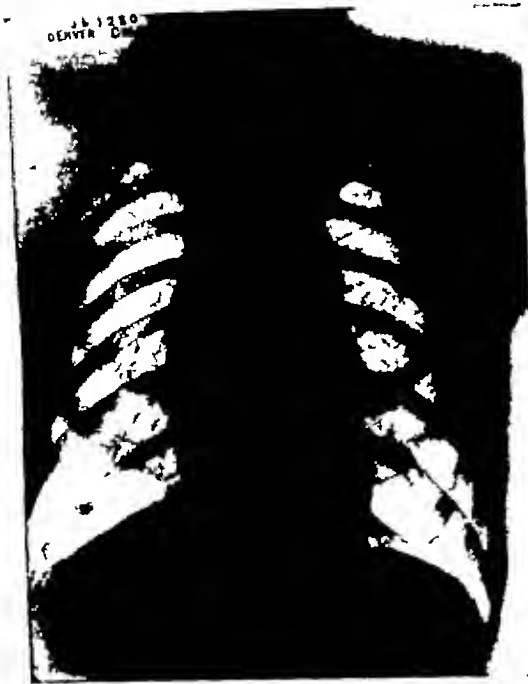


Fig. 6 (above) Pulmonary tuberculosis with an area of calcification in the right base and changes in the lymphatics extending along the arteries and bronchi to the lymphatic nodes in the lower portion of the right lung root. Here the disease involves primarily the lymphatic system and only secondarily the ventilating system and to a still less extent the circulating system.

Fig. 7 (below) Disease of the circulating system without anatomical changes demonstrated in the ventilating or lymphatic systems. The disturbance of the air content of the secondary lobules in the bases can not be classified without a study of other anatomical changes especially those of the heart.

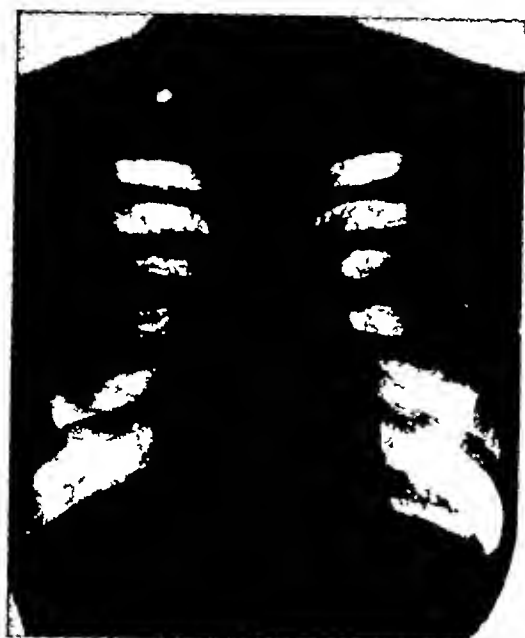


Fig 2 An average normal adult chest with a small insert on the right to indicate the relative size of a secondary lobule, which, according to Miller, measures 1.5 to 2.5 cm or more in diameter and contains from 50 to 250 primary lobules

shadow but have an entirely different pathologic appearance and origin. The pathologist may describe the destruction of the bronchial walls or their air sacs by destructive processes, or demonstrate an increase in their thickness or density by the formation of fibrous tissue, but the differentiation between these two processes within a small group of anatomic units as portrayed on a roentgen film would be impossible by the roentgenologist, if only the small localized lesion is considered.

- (c) The pathologic reactions within the arteries, the veins and their capillaries

Again the pathologist may describe a stasis of the flow within the capillaries of a necropsy specimen which upon the roentgen film of a clinical patient will cast a shadow similar to that of a cellular exudate within the bronchioles and their air sacs or a shadow similar to an edema of these structures. Increased flow within the

(d)

In a given patient with clinical manifestations of disease of the lungs, there will also be roentgen evidence of the disease. A patient with a typical clinical syndrome will usually have a typical roentgenographic syndrome.

The structural changes of the roentgenographic syndrome are portrayed chiefly by their disturbance of the normal position or relationship and the relative amount of the air content of the lungs.

The study of this air content of the anatomic units and particularly of the structural changes throughout the chest is the basis for the differential diagnosis.

ADDITIONAL READING

- (1) MILLER WILLIAM SNOW Key Points in Lung Structure RADIOLOGY, March, 1925, 4, 173-177
- (2) Idem Key Points in the Architecture of the Lung U S Vet Bur Med Bull, April, 1926, 2, 341
- (3) Idem Reconstruction of a Tubercle Am Rev Tuberc., 1919-20, 3, 65
- (4) Idem Reference Handbook of the Medical Sciences, 1916, 6, 89
- (5) DUNHAM, KENNON, and SKAVLEM, JOHN H Basic Points in Roentgen-ray Studies of the Lung Anatomy and Pathology Ann Int Med November, 1935 9, 555-568
- (6) KÖLLIKER, A Manual of Human Histology 1934, 2, 179 (printed for the Sydenham Society, London)
- (7) CORYLLOS, P N, and BIRNBAUM, G L The Circulation in the Compressed Atelectatic and Pneumonic Lung Arch Surg, December 1929, 19, 1346-1424
- (8) MULLER G P, OVERHOLT R H, and PENDERGRASS, E P Post-operative Pulmonary Hypoventilation Arch Surg December, 1929 19, 1322-1345
- (9) MILLER WILLIAM SNOW The Lung Charles C Thomas, 1937

capillaries must exist but has little roentgen consideration. Occlusion of a nutrient artery may take place and produce a necrosis of the anatomic units preceded by the usual inflammatory changes. Or again, the capillaries may be occluded by tumor cells, with the subsequent formation of a metastatic nodule. There may be destruction of the vascular walls by acute infections or an increase in the supportive framework by more chronic inflammatory process. I wish to point out that few of these pathologic processes taking place within the vascular system of the anatomic units, can be differentiated from certain pathologic reactions in the bronchioles and air sacs, where the air content is completely obliterated, if only a small group of anatomic units are considered and if no consideration is given to the structural changes in the rest of the chest.

Pathologic reactions within the lymphatic system. In the pathologic processes involving the lymphatics, the following conditions may occur:

- 1 The lymph channels may become distended or they may be compressed by adjacent disease.
- 2 The walls of the lymphatic channels may be caught in the pathologic process and destroyed, or in the more chronic conditions the walls may be thickened with definite fibrosis.
- 3 The flow of lymph may be blocked by cells or debris.
- 4 Nodes of lymphoid tissue are not plentiful within the anatomic units, but those present may have acute inflammatory reactions or chronic fibrotic reactions.

When such pathologic reactions within the lymphatic system of the anatomic units reach sufficient proportions as to interfere with the air content

Three major reasons will be advanced to support the contention that filtered rays are indicated in preference to the unfiltered ones

- 1 The skin recovery following the Coutard method
- 2 The response of inflammatory conditions to small filtered roentgen doses
- 3 The radiobiological selectivity

I SKIN RECOVERY FOLLOWING THE COUTARD METHOD

In 1928 Coutard described and developed his technic. It was worked out in an attempt to imitate, as nearly as possible, the continued radium application as employed by Regaud and Nogier. The selective action of small amounts of radium employed for a long time had been noted by Regaud in treating malignant tumors. Consequently, Coutard substituted the short, penetrating x-ray in place of the radium, which necessitated the use of heavy filters and the administration of fractionated x-ray at low milliamperage. A severe skin reaction resulted similar to that produced by the Regaud radium method. Coutard distinguished between two forms of skin reaction, one, a radio-epithelite, and the other a radio-epidermite, the former being observed 14 days and the latter 28 days after the beginning of treatment. Dermatologists were rather reluctant to adopt this form of treatment for malignancies of the skin as they were interested in skin recovery and feared that permanent post-radiation sequelae might be extremely distressing. But now the Coutard method has been used long enough so that an effective volume of data has been collected on skin recovery and skin repair. The epidermolysis which follows the Coutard protracted fractionated treatment produces from a partial to a complete destruction of the epidermal layers of the skin leaving, however, a dermal layer with its vascular and connective tissue elements relatively intact. Epidermal regeneration occurs through the growth of the basal layer at the edge of the treated areas and by islands of epithelium which remain in the hair follicles. A soft

pliable skin results. The changes in the cutis according to Schreus and many others, show little or no tendency to produce hard indurated fibrous tissue, and, on recovery, relatively little change is noted in the vascular system of the cutis. It is in these respects that the cutis presents a markedly different histopathologic picture than that found following the use of repeated roentgen-ray treatments with erythema or sub-erythema doses. The latter type of treatment may result in a chronic radiodermatitis with marked change in the connective tissue and vascular system of the cutis. Clinically, this change can be detected by evidence of atrophy and induration. The very fact that there is better skin recovery following the Coutard technic than there is following the divided erythema or sub-erythema doses without filters, forms one of the strong arguments for the use of filters. Likewise, it forms a strong argument for the use of higher voltage and more filtration, as it is by this method that a homogeneous or a monochromatic type of ray may be developed and used.

II RESPONSE OF INFLAMMATORY CONDITIONS TO SMALL FILTERED DOSES

The changes effected in inflammatory tissue by filtered roentgen rays may be mentioned as one of the indications for the use of filtered radiation in treating the common dermatoses. A review of the literature shows that metallic filters are employed as a common procedure by the radiologist in treating inflammatory diseases. Only one reference, Gaston Daniel,¹ was found with a technic employing 1 cm. of leather in the place of a metallic filter. This form of treatment was advocated for paronychia and furunculosis. Daniel employed a low kilovoltage of from 24 to 28 kv. with 1 mm. of aluminum filter and a dose of from 10 to 60 r for most of the inflammatory conditions. In this respect he is unlike many other therapists who employ a kilovoltage ranging from 80 to 200 kv. Daniel states

¹ Bull. et Mem. Soc. de Radiol. Med. de France (Marseille Bull.) May 1937.

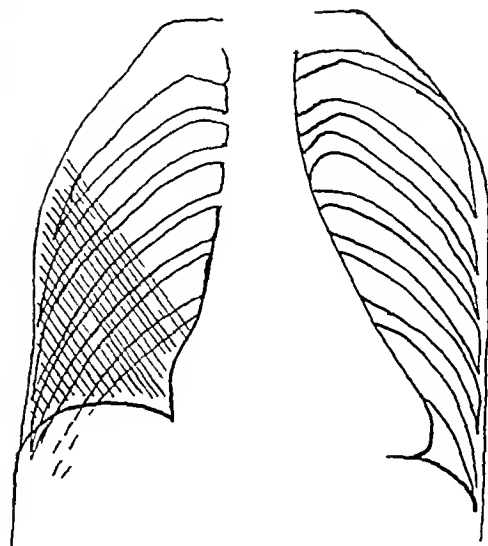
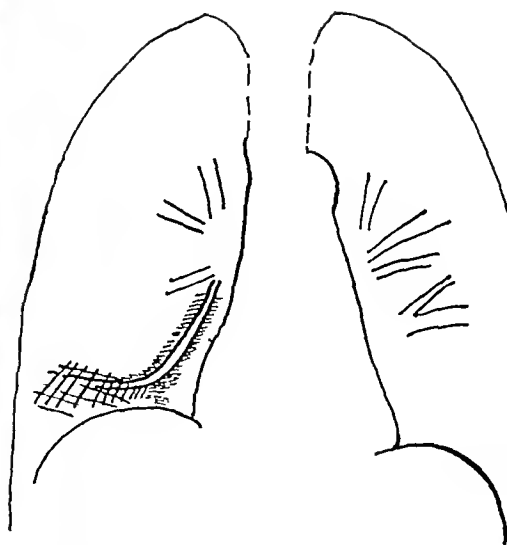


Fig 4 (*above*) Pneumonia of the right base with involvement of the bronchus leading to the right lung root and an associated involvement of other bronchi of either lung root illustrating a disease primarily of the ventilating system but the diagnosis is not made entirely by the changes in the primary and secondary lobules

Fig 5 (*below*) Atelectasis of the right base involving especially the air sacs of the ventilating systems with a diagnosis made by the changes in other anatomical structures as the sloping ribs and the high diaphragms

certain dermatoses the pathology is extremely superficial, being confined largely to the upper layers of the corium and to the epidermis. But many of the dermatoses are the manifestations of constitutional diseases and the pathology is not confined entirely to the dermis. Filtered roentgen ray does penetrate beyond the skin pathology, and one should not overlook the fact that the benefits of irradiation therapy are both local and constitutional.

CONCLUSIONS

Filtered rays, in from one-eighth to one-fourth S E D, should be used in preference to the unfiltered rays in treating the inflammatory and common dermatoses. They can be repeated often if the diseased condition warrants it, with less hazard to the integrity of the skin. It is better to err on the side of filtered radiation than to err on the side of overdosing with unfiltered rays.

of the adjacent air sacs, and when a sufficient number of units are involved, the reactions may be portrayed upon the roentgen film. The differential diagnosis of any one reaction, causing a disturbance of the air content from pathologic reactions within the ventilating system or circulatory system, requires more than the study of the anatomic units comprising a few secondary lobules.

- (e) The reactions within the connective tissue framework supporting the bronchioles and the air sacs, the arteries, veins and their capillaries, and the lymphatic system may either undergo acute inflammatory changes or chronic fibrosis.

A discussion of their roentgen portrayal would be similar to that of the lymphatic system.

III Classification

It is evident from the foregoing brief description that the pathologic reactions within the anatomic units may be divided into those involving

- The ventilating system
- The vascular system
- The lymphatic system

The reactions of the connective tissues or the supportive framework of the systems are secondary to the pathologic reactions within the ventilating, the vascular, or the lymphatic system. As just mentioned, the pathologist describes many reactions which are quite different in both appearance and origin, but as portrayed upon the roentgen film many of these reactions will cast the same type of shadow. The roentgenologist in considering a small group of anatomic units as one or two secondary lobules, may be able to differentiate a disease of the bronchioles and air sacs as in emphysema from an occlusion of the air sacs as in atelectasis or pneumonia, but when considering only one or two such secondary lobules,

he could not differentiate atelectasis from pneumonia. For the latter differentiation he must turn to the structural changes in other portions of the lungs, the mediastinum and its structure, or the chest wall. Again in the stasis of flow within the capillaries, as in cardiac failure, a certain group of anatomic units might have the same appearance as a similar group of units in bronchopneumonia and only by an analysis of the heart outline and the changes in other portions of the lungs could one differentiate between the two. In other words, there are only a few pathologic reactions within the anatomic units of the lung which are distinctive or portrayed in a distinctive manner upon the roentgen film. The diseases involving the anatomic units do permit themselves to be classified into those primarily of the ventilating system, the vascular system, or the lymphatic system. The differential diagnosis is most frequently made by a study of the structural changes in the rest of the bronchial system when the bronchioles and air sacs are involved. In diseases of the vascular system with stasis of flow in the capillaries, the differential diagnosis is made by a study of the heart and great vessels, the location of the shadows, and the anatomic appearance of the rest of the chest. Again, the diseases primarily of the lymphatic system are differentiated from those of the ventilating, or vascular system by a study of the reactions within the lymph nodes along the major arteries and bronchi, or of those nodes at the lung roots or in the mediastinum. The attempt should always be made to differentiate and classify the diseases of the lungs into those of the ventilating system, the vascular system, and the lymphatic system. This should be done by a study of the structural changes, whether in the anatomic units or the other portions of the chest.

IV The Diagnosis

The diagnosis of chest diseases and especially those involving the parenchyma or the anatomic units of the lungs is based upon certain general considerations

measured by the thimble chamber any place but in air the symbol r or the term, roentgen, are placed in quotations

No systematic study has been made of the dose necessary to produce an erythema at one sitting. Our treatments are all given by the protracted method. As nearly as we can estimate, 800 r produced a definite erythema with the high voltage when given to a field 10 by 10 cm in size at the rate of 12 r per minute. The difference between this and Holthusen's figure of 1,050 is probably caused by measuring the r in beams of different sizes. When the 800 r was given at the rate of 18.4 r per minute (due to lesser filtration) a more marked erythema resulted. With supervoltage radiations (1,000 kv) 1,000 r to a field 15 by 15 cm over the lower abdomen at the rate of 25 r per minute produced a very definite erythema and marked pigmentation. On the opposite side of the same patient's abdomen, 800 r of high voltage radiations, at the rate of 18.4 r per minute, produced in 35 days a more marked erythema with pigmentation, 50 days after the treatments no difference between the two sides could be detected. Eight hundred r of supervoltage radiations, at 25 r per minute, produced no change in fields measuring 10 by 10 cm on the shoulder, abdomen, or hip.

Much more material is available for a comparison of the results of protracted treatment. The pelvis will be considered first. The routine in treating the pelvis is to use two fields anteriorly and two posteriorly, each 10 by 15 cm in size. One anterior and one posterior field are treated one day, the other two fields the next day. Treatments are given daily except Sunday. With the use of the 200 kv apparatus, 200 r per field per treatment—reaching a total of 2,000 r per field in 20 treatments during a period of 23 days—produced a definite erythema anteriorly with the formation of occasional vesicles, and a faint erythema posteriorly. When the filter was 0.5 mm Cu and the rate of giving 18 r per minute the reaction was slightly more severe than

when the filter was 0.2 mm Sn plus 0.25 mm Cu and the rate 12 r per minute.

When the supervoltage was first used, 316 r per treatment, totaling 3,160 r per field, were given at the intensity of 31.6 r per minute. This produced a reaction considerably greater than that from the high voltage. Some of the reactions were so severe that treatments had to be stopped before completion, and the late results are now known to be too intense. In time it was found that 250 r per field per treatment, to a total of 2,500 r given at the rate of 25 r per minute, gave almost the same reaction as that obtained by the use of the high voltage, with the exception that it was about one week slower in reaching its peak, and that, while the pigmentation was about the same, there was less tendency to the formation of vesicles. The skin remained drier throughout.

On a few patients, one field on each surface was treated with supervoltage and the other with high voltage. In some, the supervoltage was given to the same side of the pelvis both anteriorly and posteriorly, and in others the opposing fields were treated with the differing qualities. In all these cases the fields treated with the 200 kv radiations showed a slightly more marked erythema, but those treated with the 1,000 kv radiations showed a more uniform reaction over the whole field. The pigmentation seen later was about equal for the two types of radiation.

From the preceding discussion, it appears that 200 r, air measure, of 200 kv radiations given in 23 days elapsed time produces approximately the same reaction of the skin over the pelvis as 2,500 r, air measure of 1,000 kv radiations. Lauritsen (1) calculated the number of theoretical roentgens required to cause the absorption of the same number of ergs per square centimeter of a surface layer of water 1 mm thick at different monochromatic equivalent voltages. From his curve it can be seen that 525 r and 1,100 r delivered by 100 kv radiations (200 kv peak?) and 500 kv radiations (1,000 kv peak?), respectively, give the same num-

DERMATOROENTGEN THERAPY

SHOULD THE COMMON DERMATOSES BE TREATED WITH FILTERED OR UNFILTERED RAYS?

By C K HASLEY, M D , *Detroit, Michigan*

THE present status of dermatoroentgen therapy is in a state of flux

There has been no unanimity of opinion regarding the indications for the use of filtered and unfiltered rays. Many dermatologists employ unfiltered irradiation almost to the exclusion of filtered radiation. In our opinion, unfiltered rays are being used too extensively and too thoughtlessly. Unfiltered radiation is not always desirable even when little or no penetration is required to effect a cure. It is true, small doses do not provoke immediate damage, but the accumulative effect of fractional unfiltered doses is prone to produce a chronic roentgen dermatitis which may be serious in later years. Every physician who uses the roentgen ray for therapeutic measures should not only be thoroughly acquainted with both its possibilities and its limitations, but should attempt to prevent all detrimental post-radiation sequelæ.

To-day, our concept of skin tolerance and skin recovery is vastly different from what it was a decade or two ago. Formerly, the erythema dose (S E D), with its many sources of error, was regarded as the absolute tolerance dose and hence the maximum dose of safety. To-day, when the disease process warrants extreme therapy, many erythema doses are given, as, for example, in treating malignancies of the skin and deeper tissues. This is done without fear of permanent damage to the skin. The technics commonly employed for multiple erythema dose treatments are The Pfahler saturation method, the Coutard protracted fractionated method, and Hofelder's combination of the above two types of treatment.

Consequently, with the changed concept of skin tolerance it is *à propos* to ask again, what kind of rays are best suited for the treatment of common dermatoses? The

answer is a difficult one. There are multitudes of variable factors which enter into a safe dermatoroentgen dose. If only one factor is changed at a time, the possibilities for dose variation assume geometric proportions. For example, the quality (wave length) of a skin dose may be changed by the potential. The quantity may be changed by the filters, by the time, by the milliamperage, by the distance, by the size of the field, etc. If the answer to the above question assumes any degree of finality, it presupposes the proper interpretation of all the experimental work in the biophysical, biochemical, and biological action of rays on living tissue. With such a multiplicity of variable factors, it is quite easy to understand why the empirical dermatoroentgen dose has been passed on and on, and it is also easy to understand why a permanent skin damage has not been done, as the total dose has not exceeded the skin recovery dose.

But, to-day, the chances for over-exposure by the divided and fractionated method are greater than ever before as the field of usefulness of irradiation therapy is greater. It is now being used in treating many diseases of infancy, childhood, and adolescence such as infections, allergy, and dermatoses. Consequently, it is necessary to exercise greater precaution to keep the accumulative factor of x-ray well below the skin tolerance.

It will be impossible to present within a limited discussion more than a few of the diversified factors which enter into a dermatoroentgen dose. The scope of that field is entirely too extensive for a discussion of this kind, but it is possible to point out some of the experimental work which has recently been done which will support the contention that unfiltered rays are being used too extensively in the treatment of common dermatoses.

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No systematic study has been made of the dose necessary to produce an erythema at one sitting. Our treatments are all given by the protracted method. As nearly as we can estimate, 800 r produced a definite erythema with the high voltage when given to a field 10 by 10 cm. in size at the rate of 12 r per minute. The difference between this and Holthusen's figure of 1,050 is probably caused by measuring the r in beams of different sizes. When the 800 r was given at the rate of 18.4 r per minute (due to lesser filtration) a more marked erythema resulted. With supervoltage radiations (1,000 kv) 1,000 r to a field 15 by 15 cm. over the lower abdomen at the rate of 25 r per minute produced a very definite erythema and marked pigmentation. On the opposite side of the same patient's abdomen, 800 r of high voltage radiations, at the rate of 18.4 r per minute, produced in 35 days a more marked erythema with pigmentation, 50 days after the treatments no difference between the two sides could be detected. Eight hundred r of supervoltage radiations, at 25 r per minute, produced no change in fields measuring 10 by 10 cm. on the shoulder, abdomen, or hip.

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that a small roentgen dose is imperative to the safety of the method. He notes improvement even when a small dose of 10 r is given, exceeding, he believes, the benefits of surgery and immunization. Daniel advocates the use of x-ray therapy in the treatment of acute and—think of it—hyperacute inflammatory conditions. In this particular respect he shares the opinion of the newer schools. Many of the inflammatory conditions are definite indications for the use of irradiation therapy, and an inflammatory skin condition is no longer regarded as a contra-indication to the use of roentgen rays.

V. G. Garshin, M. M. Bolshakova, and V. V. Orsinskaya² produced an aseptic inflammatory lesion experimentally by a subcutaneous injection of a 1–2 per cent suspension of infusorial earth into a rabbit's ear. When one skin erythema dose was given and repeated every four days for three times, no noticeable change was observed in the induced aseptic inflammatory granuloma, but a marked change was noticed when one-half SED was given every other day for six times. On section, the number of nuclei in the macrophage was greatly reduced over the control. Still greater change was observed when one-fourth SED was used. The giant cells and their nuclei were much smaller than their controls.

From their experiments these workers concluded that small fractional doses given at short intervals are more effective than larger doses at longer intervals. The clinical observation of many radiologists will support this contention. The late Dr. Manges, in an editorial entitled "Roentgen Therapy of Acute Inflammations and Infections,"³ states: "The specific effect of roentgen radiation in infection may not yet be understood, but, empirically, under proper use and favorable circumstances, it is just as valuable as quinine was before the malarial parasite was discovered." The

roentgen effect is due, in part at least, to the radiosusceptibility of the lymphocytes and the leukocytes. Only a small amount of irradiation therapy is needed to produce a destruction of the lymphocytes and in all probability an antibody is liberated on its destruction. Filtered doses permit the repetition of irradiation therapy frequently, if necessary, whereas the use of the unfiltered radion is limited.

III THE RADIOBIOLOGICAL SELECTIVITY

For years, and notwithstanding the lack of experimental proof, some radiologists have felt, from the response of certain types of tumors to irradiation therapy, that the beneficial reaction was in part due to the selective quality of the waves. Some recent experimental observations tend to support this radiobiological theory. Henshaw and Francis, at the Fifth International Congress of Radiology, September, 1937, reported the results of experiments on seedlings, *Drosophila* eggs, yeasts, mouse sarcoma, etc., by using 30, 200, and 650 kv. The different radiations in like quantities and with like conditions produced different or unlike radiobiological effects. Consequently, they concluded that a differential action was due to the quality of radiation and that a selectivity of radiation does exist. They emphasized the point that the differential action cannot be neglected in considering the practical utility in radiation therapy.

These observations and conclusions are being cited to support the feeling that unfiltered rays are being employed too extensively, as the selectivity of the ray is increased by using a higher kilovoltage and more filters.

The trend in the treatment of infections as given by the radiologist is in the direction of greater filtration, and higher kilovoltage. But, unfortunately it does not seem to apply to the method usually employed by the American dermatologist in treating inflammations of the skin. The dermatologists hold that for successful and safe roentgen treatment only the pathology should be treated. And it is true that in

² State Roentgenologic Radiologic and Cancer Institute

³ Am Jour Roentgenol and Rad Ther March 1936

kv radiations than for 200 kv radiations. When back-scatter, the "exit dose," and the equivalent dose as measured by small biological test objects are taken into consideration the number of "roentgens" as measured on the skin is almost the same for supervoltage as for high voltage radiations when the same reaction is produced.

The practical roentgen therapist is interested in knowing whether, for the same reaction of the skin, a greater amount of energy can be delivered into the body and absorbed there by the use of the one radiation or the other. From Lauritsen's calculations on the theoretical roentgen and monochromatic equivalent voltage, it is found that the total amount of energy in the beam for the same absorption of energy per square centimeter of the surface increases rapidly with the equivalent voltage. Thus it would seem that even though the effect on the surface is the same for the two voltages, the actual amount of energy delivered into the patient would be much greater for the supervoltage. In therapy, however, one is concerned not with the energy delivered, but with the energy absorbed.

If the ionizing effect in a thimble chamber at various depths is accepted as an index of the amount of energy absorbed, then that amount is greater under some conditions for high voltage than for supervoltage radiations. Maynard and Roberts (1) have shown, for radiations up to 370 kv, and Stone and Abersold (3) for radiations up to 1,000 kv, that the dose at various depths up to 8 cm is somewhat greater at lower voltages than at higher. The variations in this dose depend on the size of the field and the focal skin distance as well as on the kilovoltage. When cross-fire technique is used the greater exit dose with supervoltage also decreases the total dose that can be delivered to the center of sections of finite thickness.

In the Section on Physics of this Congress Abersold and Chaffee (5) are reporting measurements made on sections of finite thickness with various sizes of fields using direct cross fire. They have found that using a field 50 cm² in size 80 cm

target-skin distance and voltage factors as described above, equal or greater doses can be delivered to the center of solid sections up to 12 cm thick, for the same surface "r" doses, by 200 kv than by 1,000 kv radiations. For fields 100 cm² in size this holds true up to 14 cm², for 225 cm² up to 16 cm, and for 400 cm² up to 18 cm.

It is thus obvious that, when considering sections of definite thickness, more ionization is produced in the center of thin sections when using 200 kv than when using 1,000 kv radiations. If the effect on tissues depends on ionization alone, and if the thimble chamber gives a fair estimate of that ionization, then 200 kv radiations may be superior to 1,000 kv radiations in some situations.

It is an all too common belief that the effect on the skin is the only factor limiting the amount of radiation that can be given. When treating pelvis with either 200 kv or 1,000 kv radiations we have frequently found that we have had to stop treatments because of a severe diarrhea, or that, long after treatments have been completed, the patients have continued to complain of pain in the abdomen which we believe to be the result of injury to the intestines. Some months after the skin of the neck has completely recovered we have found patients who had been treated for lesions of the throat still suffering from severe edema of the mucosal and submucosal tissues. Treatments to the chest which have caused no changes in the skin have given rise to severe reactions in the lungs. All of these complications have been obtained as frequently by 200 kv as by 1,000 kv radiations when the 200 kv radiations were delivered from a distance of 80 cm. Hence, it is my belief that with a proper use of 200 kv radiations as much effect can be produced in the interior of all but the thickest patients as their tissues will stand. Progress is to be made not by increasing voltage but by changing such factors as protraction and the rep minute intensities. Supervoltage is useful for producing high intensities at long target-skin distances but one must not confuse the effects of increased target-

SKIN REACTIONS CAUSED BY 1,000 KILOVOLT AND 200 KILOVOLT RADIATIONS¹

By ROBERT S. STONE, M.D., *San Francisco, Calif*

From the Department of Surgery, Division of Roentgenology, University of California Medical School²

WHEN supervoltage radiation became available for treatments one of the advantages claimed for it was that much heavier doses could be administered through the skin without damage. Lauritsen (1) made some calculations of the energy absorbed in the surface when one roentgen was measured in beams of various qualities. These calculations suggested but did not state that more than double the number of roentgens, as measured in air, could be given with 1,000 kv than with 200 kv radiations. In our experience this is not true in the practice of roentgen therapy.

In the following discussion the term "high voltage" refers to the radiations from a 200 kv General Electric X-P tube activated by a constant potential apparatus at 200 kv and 15 ma, and filtered through the wall of the tube (0.2 mm Cu equivalent) and 0.2 mm Sn, 0.25 mm Cu and 2 mm Al, or 0.5 mm Cu plus 1 mm Al, as stated. "Supervoltage" refers to the radiations from the Sloan high frequency generator, operated at from 600 to 1,200 kv and filtered through the tube wall of 1.5 mm Cu plus 3 mm steel, and then through 2 mm Pb, 1 mm Cu, and 1.5 mm Al. When it first went into operation in 1934 this apparatus ran at 600 kv. Before the end of the year it was operating at 900 kv. In 1935 it was operating most of the time at 900 kv, but for two months 1,200 kv were generated. During 1936 the operating voltage was 1,000 kv.

To compare accurately the results obtained by the use of these high voltage and

supervoltage radiations it is necessary to vary no factors other than the quality of the radiation. The size of the fields, daily dosage, total dose, protraction in days and rate of giving (r per minute) must all be the same. We have kept them all as constant as possible except the r per minute. In 1934 the rate of giving for pelvic cases was 18.4 r per minute with the high voltage, and 31.6 r per minute for the supervoltage. Since then the first mentioned has been decreased to 12 because of increased filtration. At the same time the rate of giving the supervoltage radiations was altered to 25 r per minute because of changed emission. According to Holthusen (2), this would cause a change in the dose necessary to produce an erythema from 1,050 r at 12 r per minute to 850 r at 31 r per minute.

The roentgens are all recorded as if measured by a Victoreen condenser r meter and, unless otherwise stated, were measured in air. The measurements were made in the center of a beam 15 by 15 cm in size with the thimble chamber against the end of the cone which was covered with celluloid or felt. At the beginning the measurements were actually made with an open air chamber on the supervoltage apparatus, and with a Fricke-Glasser dosimeter on the high voltage. Later they were correlated with the present Victoreen condenser r meter and all the readings converted to this standard. The symbol, "r," and the term, "roentgen," are used interchangeably for measurements made with the Victoreen condenser r meter in air whether in the 200 kv or 1,000 kv beams, even though it is recognized that such measurements of 1,000 kv radiations may not be absolutely correct. *When the measurements refer to the ionization*

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

² This study has been aided by a grant from the Christine Breon Fund for Medical Research.

elapsed time produced a severe epidermitis from which the skin recovered in the second month

A sufficient number of examples have now been given to show that the doses given and the reactions which resulted do not differ greatly whether 200 kv or 1,000 kv radiations are used. While it is too early to speak of end-results, the number of patients already dead convinces us that no great improvement over the results obtained by 200 kv radiation with similar protraction can possibly result.

In the foregoing discussions no account is taken of any as yet unproved wave length effects.

SUMMARY

1 A comparison is made between the effects on the skin obtained by the use of radiations from a 200 kv constant potential apparatus and from a 1,000 kv Sloan type generator.

2 It is shown that, while an increase of 25 per cent in the number of roentgens measured in air can be given with the 1,000 kv radiations, the increase in the dose as measured on the skin, with the addition of the exit dose, is negligible.

3 The amount of energy absorbed in the depths as measured by a thimble chamber ionization meter is not greater in many thin parts for 1,000 kv than for 200 kv radiations.

4 The limiting factor in many instances is not the skin reaction but the reaction of the mucosa and other deep structures, whether 1,000 kv or properly used 200 kv radiations are employed.

5 The real value of 1,000 kv radiations lies in the treatment of very thick patients, or when very small fields can be used.

6 Progress in radiation therapy is more likely to be made by varying factors other than kilovoltage.

REFERENCES

- (1) LAURITSEN, CHARLES C. *Am Jour Roentgenol and Rad Ther*, October, 1933 30, 529-532
- (2) HOLTHUSEN H and BRAUN R. *Grundlagen und Praxis der Röntgenstrahlendosierung* Leipzig 1933
- (3) STONE ROBERT S and AEBERSOLD, PAUL. *RADIOLOGY*, September, 1937 29, 296-304
- (4) MAYNEORD, W V, and ROBERTS J E. *British Jour Radiol*, June, 1933, 6, 321-344
- (5) AEBERSOLD, P and CHAFFEE M. *Practical Considerations in the Comparison of Depth Doses Achieved by 1,000 kv and 200 kv X-ray Apparatus* (To be published in *RADIOLOGY* as read at the Fifth International Congress of Radiology, Chicago, 1937)

ber of ergs absorbed. This is an increase of over 100 per cent, whereas the present studies show an increase of only 25 per cent for supervoltage. We have not found a complete explanation of this discrepancy. The amount of back-scatter, the exit dose, the method of measuring roentgens, the rate or recovery of the skin, the value of the monochromatic equivalent voltage, and the rate of administration must all be considered.

The amount of back-scatter to the surface from a particular beam of radiation is controlled by the size of the field. For the field 10 by 15 cm in size, this back-scatter, as measured by the Victoreen condenser r meter, is 35 per cent for the 200 kv and 10 per cent for the 1,000 kv radiations. The 2,000 r air measure of 200 kv radiations, therefore, equals 2,700 "r" on the surface, and the 2,500 r equals 2,750 "r".

It was shown by Stone and Aebersold (3) that, in the case of supervoltage radiations, the exit dose becomes of appreciable size. When using 1,000 kv, 80 cm, target-skin distance and a field measuring 10 by 15 cm, it is approximately 20 per cent of the surface dose after traversing a section 20 cm thick. With 200 kv, the other conditions being the same, the exit dose is only 10 per cent. Thus to the total applied skin dose in a cross-fire technique we have to add the exit dose, 550 "r" for the supervoltage and 270 "r" for the high voltage. Adding these exit doses, which, of course, include scattering, it is seen that each surface receives 2,970 "r" from the 200 kv apparatus, and 3,300 "r" from the 1,000 kv apparatus.

We are not prepared to discuss the measurement of the roentgen of 1,000 kv radiations by the thimble chamber. We can say that with the thimble chamber which we used a slightly larger number of roentgens (about 10 per cent) was required than with 200 kv radiation to produce the same effects on small biological objects. Thus to have the same biological effect the reading of the r meter needed to be 10 per cent more for 1,000 kv than for 200 kv radiations. If 10 per cent is sub-

tracted from 3,300, we get 3,000 "r" as the surface dose from 1,000 kv radiations, in comparison with 2,970 "r" from 200 kv radiations.

The effect of the rate of recovery of the skin during protracted treatments is very difficult to measure or estimate. As was mentioned above, it takes a few days longer for an erythema, produced by a single exposure, to appear after 1,000 kv radiations than after 200 kv radiations. On the basis of previous experience with lower voltages it would seem that the recovery from 1,000 kv radiations would be slower. With protracted treatments a greater accumulative effect could be assumed to result from the slower recovery.

The monochromatic equivalent kilovoltage is one way of stating the quality of the beam of x-rays. It gives the average energy of the photons in the beam but does not describe the distribution of their energies. This fact makes it extremely difficult to apply to practice in connection with heterogeneous beams of radiation, the information obtained from calculations based on an absorption of pure monochromatic radiation. The difference in the erythema dose for the two heterogeneous beams of radiation being considered would not be so great as that calculated for pure monochromatic beams of 100 and 500 kv.

The effect of the rate of administration of radiation (the r per minute intensity) on the production of erythema is at the present time the subject of considerable controversy. It seems certain, however, that there is some effect and that it takes a larger dose to produce an erythema if that rate is low and the time taken to administer it longer than if it is high and the time shorter. If this is true it would have taken more than 2,500 r to produce the same results with the supervoltage if the rate had been 12 r per minute instead of 25.

Whatever the explanation may be, we are forced to conclude that, in protracted therapy to the pelvis as described, the number of roentgens as measured in air with the Victoreen condenser r meter can be only about 25 per cent greater for 1,000

elapsed time produced a severe epidermitis from which the skin recovered in the second month

A sufficient number of examples have now been given to show that the doses given and the reactions which resulted do not differ greatly whether 200 kv or 1,000 kv radiations are used. While it is too early to speak of end-results, the number of patients already dead convinces us that no great improvement over the results obtained by 200 kv radiation with similar protraction can possibly result.

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REFERENCES

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skin distances with those of increased voltage

Some of the doses actually administered are of interest and value to those contemplating supervoltage therapy. In nearly all regions of the body we treat opposing fields on alternate days, and have used 20 days of treatment in from 20 to 25 days elapsed time as our mean. In general, it may be stated that the immediate skin reaction from 1,000 kv radiation tends to be drier for the same degree of pigmentation as seen at the end of two months than that produced by 200 kv radiation.

Tables I and II show the results in a few patients treated over the pelvis and selected because the records of the reaction of the skin at various times were sufficiently complete. They show that those treated with an average of 300 r per port per treatment, to a total of 3,000 roentgens per port in from 20 to 25 days elapsed time, had a higher percentage of severe immediate reactions and all of the late severe changes. We have treated a few patients with 400 and more roentgens per port per treatment, reaching totals of 4,000 roentgens per port in from 20 to 25 days. All of these have had very severe primary reactions that were slow to heal.

Table III shows the mucosal reactions as estimated by the severity of the diarrhea produced. It is plain that marked diarrhea is frequently caused by the smaller doses which gave the less severe skin reactions. It is our belief that in treating pelvis there is no justification for producing severe skin or mucosal reactions. The results do not justify the immediate suffering nor the threat of late changes. All of those treated with more than 300 r per port per treatment developed very severe diarrhea.

In the treatment of lesions of the throat we have frequently prolonged the treatment beyond the 20 sittings and have varied the daily dose because of the general reaction. We have also found great variation in the skin and mucosal reactions of individual patients. We have frequently added a posterior port to the two lateral ports without noticeably increasing the

skin reaction. In general we have given an average of 265 r per port to opposite ports and treated them on alternate days to an average total of 2,800 r per port. Of 24 patients so treated only eight had a severe epidermitis, whereas 20 had severe epithelitis. The period of observation has been too short to tell what the late changes in the skin will be, but we know that many patients have developed marked edema of

TABLE I—PELVIS—EARLY SKIN REACTIONS
1 000 KILOVOLTS

Daily Dose per Port	Total Dose per Port	Type of Reactions			
		None	First Degree	Dry Peeling	Second Degree
300	3 000	0	3	8	6
250	2 500	2	4	13	4

TABLE II—PELVIS—LATE SKIN REACTIONS
1 000 KILOVOLTS

Daily Dose per Port	Total Dose per Port	Type of Reaction			
		Recovery	Dry Pigmentation	Telangiectasis	'Leather' Skin
300	3 000	4	0	2	4
250	2 500	6	6	0	0

TABLE III—PELVIS—MUCOSAL REACTIONS

Daily Dose per Port	Total Dose per Port	Degree of Diarrhea			
		None	Mild	Moderate	Severe
300	3 000	1	0	9	2
250	2 500	3	3	6	4

the throat. We feel that we are limited by the mucosal changes more than by the skin changes, but this same condition holds true for 200 kv radiations if heavily filtered and given with 80 cm target-skin distance. We have used fields 10 by 10 cm in size, or larger, in most cases.

Eight patients with lesions of the breast, not operated on, have been treated by the tangential method using two oblique fields 10 by 20 cm or larger. In these cases an average of 2,500 r per port in 23 days

colloid type of material not unlike that found in the left lobe of the thyroid gland and in the aberrant mass present in the mediastinum

"In a portion of the third thoracic vertebra there was an area of colloid material similar to that found in the clavicle, having replaced the bone and communicating with the spinal canal, the growth extending into and pressing on the spinal cord at this point. Chronic deforming spondylitis involved the fourth to sixth dorsal and several of the lumbar vertebrae

"Histologic Findings—Bronchopneumonia. Colloid adenoma of the thyroid gland (Fig 10-A). Metastatic tumors, consisting of colloid adenoma, involved the mediastinum, the right clavicle, the third thoracic vertebra "

Otherwise, this autopsy revealed no evidence of anomalies or disease processes

Correlating this autopsy report to those points of the patient's history recorded above, one feels inclined to conclude that several years before his death a pneumonic infection lead to the rupture of a caseated tracheobronchial lymph node which discharged its contents and subsequently healed without having produced a parenchymal dissemination of a tuberculous infection. Furthermore, metastases occurred in the mediastinum and skeletal segments from an adenoma of the thyroid gland. The pathologist was unable to find any evidence of carcinoma, either in the primary adenoma or the metastases. Clinically, no tumor of the thyroid ever was apparent. While offhand one would feel inclined to share Simpson's view referred to, this case might be cited in favor of the assumption that occasionally histologically benign tumors of the gland metastasize to distant organs

In connection with this case of metastasizing adenoma of the thyroid we include in this report a résumé of the early history of a multiple myeloma which is quite interesting. We regret though that a complete review is impossible as this patient was seen only a few times in consultation. He died finally in another institution, and detailed information later on was refused us by this hospital. Seventeen months prior to the first consultation this patient, white male age about 50

years, while camping in a Canadian cottage during a cold wintery night developed a swelling in the right cervical gland region with a sensation of a wry-neck. The soreness disappeared slowly, but the swelling of the glands persisted. The patient visited a well-known hospital but, dissatisfied, left their care. Subsequently, a pediatrician friend examined him and apparently regarded the glandular swelling very lightly, informing him that it would probably disappear without any particular treatment, though this resolution might require several months. One year after the onset of this swelling another physician was consulted. He resorted to treatment consisting of subcutaneous injections, which in all probability contained arsenic, iron, and strychnine. When no result was obtained, a biopsy was suggested and finally performed 15 months after the onset of the disease. The pathologic report submitted by a highly competent examiner was "Lymphosarcoma of the reticular cell type." Later, the patient received extensive radiation therapy to neck, supraclavicular regions, both axillae, mediastinum, spleen, and both groins. The effects of this treatment upon the lymphadenopathy in the neck were entirely negligible although unquestionably full erythema doses were applied under heavy filtration, from which the resulting tanning was quite apparent at the time he visited us.

In consultation we observed a rather hard adenoma in the thyroid just to the left of the midline. There was an extensive lymphadenopathy involving the cervical lymph nodes on the right side. These nodes were of hard consistency, the overlying skin, as mentioned, was quite tanned, and no hair was present. There was evidence of a former otitis media and mastoiditis, with partial sclerosis of the temporal bone and formation of a very large cell—demonstrated roentgenographically. Roentgenologic examination of the chest revealed a deviation of the trachea to the right at the upper thoracic aperture with a mild hourglass-shaped compression of the

skin distances with those of increased voltage

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A 9 17 36

B 5 14-37

C 5-14-37

Fig 1

plicable anemia, and (6) chronic nephritis with nitrogen retention, low blood pressure, and high serum protein. To their collection we add two cases.

Case No. 37704. White male, aged 50. Thirteen years prior to admission he had suffered from a "renal infection." For five months previous to admission he noticed gradually increasing sensory and motor disturbances in his lower extremities—"did not know where his abnormally cold feet were, sensation of needles in his legs, loss of co-ordination of lower extremities, loss of motor power now extending to the lower ribs." He also complained much of lumbar back pain. He had been told by one physician that he was afflicted with a case of the very common lower back pain, and on this information took a number of chiropractic treatments.

On admission there was hyperesthesia extending from the feet to the umbilicus. Head and chest would perspire quite profusely down to the eighth dorsal segment, but the body was dry below this level. Reflexes were lost in lower limbs and abdomen, the left cremasteric reflex, however, was present. There was weakness and some spasticity of the lower extremities. Pulling the head forward caused pain in the midportion of the back. The spinal fluid

was slightly xanthochromic. A definite block was observed on jugular compression. Five cubic centimeters of ascending lipiodol were injected in the lumbar region for subsequent roentgenologic examination. Spinal fluid globulin +, total protein, 85 mg per 100 cc, two white blood cells per cmm, gold curve, negative, Eagle, Kline, Kahn tests, negative, 5,730,000 red blood cells, 11,800 white blood cells, 86 per cent polymorphonuclears, 14 per cent small lymphocytes.

Roentgenograms (Fig 1-A-C) showed an obstruction of the spinal canal at the level of the eighth dorsal vertebra. There was involvement of the body and both pedicles of the seventh dorsal vertebra by a bone tumor, creating isolated areas of demineralization. There was considerable dilatation of the heart and aorta. No sign of pulmonary disease was discovered, and the humeri, lumbar spine, pelvis, and femora appeared to be normal. One of our associates, who originally reported the roentgen-ray evidence, felt that a neoplasm was present in the seventh dorsal vertebra, though he did not feel entirely certain that an inflammatory process could be ruled out definitely. In consultation we suggested the probability of a myeloma. A laminectomy was performed and "the

TUMORS INVOLVING THE SKELETON

By HANS A. JARRE, M.D., Attending Radiologist, The Grace Hospital, Detroit, Michigan

TUMORS of bone present features of great clinical, roentgen diagnostic, and radiotherapeutic interest. The addition of new case records to existing compilations is desirable, particularly of neoplasms with unusual features. The presentation of the following group, therefore, seems appropriate in this issue of RADIOLOGY, especially as all of these cases were seen in the Department of which Dr. Rollin H. Stevens is the Director.

There exists in the medical literature a controversy concerning metastatic tumors developing from apparently benign primary tumors of the thyroid gland. The subject was reviewed critically by Simpson, who came to the conclusion that, on most careful analysis, all these cases should be regarded as metastases of a primary very small carcinoma of the thyroid gland, imitating types of benign tumors of the thyroid to such an extent that they are most easily confused with non-malignant neoplasms. Such a case is reported here-with.

CASE REPORT

The clinical history available at this time, 16 years after the patient's death, is most incomplete, but a careful autopsy report is available and also histologic sections.

The patient was a white male, 80 years of age. About four years prior to his death he contracted pneumonia and for some prolonged time afterward was afflicted with an unpleasant cough and expectoration. For several weeks his sputum contained numerous tubercle bacilli which, however, finally disappeared rather rapidly with all clinical manifestations of any type of pulmonary disease. In April, 1921, his right clavicle fractured without any known provocation. The x-ray report at that time stated that a fracture through the middle third of this clavicle was surrounded by an area of diminished

density of the bone, believed to represent a bone cyst. This fracture healed incompletely, with considerable delay. In the Fall of that year paralysis developed in the lower half of the body, and in roentgenograms obtained under very unsatisfactory circumstances one thought to discover a collapse of the third dorsal vertebral body. The patient subsequently succumbed to a pneumonia.

From the autopsy report by Dr. C. I. Owen, Director of the Laboratories of The Grace Hospital, we quote:

"There is a small visible and palpable enlargement in the outer third of the right clavicle, hard and bony to the touch. There is no visible nor palpable enlargement of the thyroid gland. There are no other external markings of importance.

"Right Lung—Extensive pleural adhesions over this entire lung were present. The lymph nodes at the bifurcation of the trachea were somewhat enlarged, markedly anthracotic, and upon incision into some of them, there were found caseated and partially calcified areas. A bronchopneumonia prevailed throughout the lower lobe, which was somewhat firmer on palpation, had a much redder appearance, and from the cut surface of which numerous small droplets of pus were expressed. On section of the upper lobe localized bronchopneumonic areas were found, from which also small droplets of pus exuded. The middle lobe did not exhibit evidence of disease.

"In the upper mediastinum there was a mass of aberrant thyroid tissue about $9 \times 7 \times 6$ cm. in size. Its gross characteristics were those of a colloid adenoma. This mass had pushed the trachea over to the right so that a semicircular indentation had occurred. It was not connected with the thyroid gland.

"Thyroid Gland—The right lobe, isthmus, and lower portion of the left lobe contained normal thyroid tissue. The upper portion of the left lobe over an area of about 2.5 cm. was adenomatous in character, not definitely malignant. In the outer third of the right clavicle there was an irregular enlargement about one-half again the normal diameter. At this point a fracture occurred on simple manipulation. The bone at this point consisted of a thin shell from 1 to 2 mm. thick. The medullary portion of the bone throughout contained a

The patient succumbed to his disease twelve and one-half months following the original admission to the hospital his suffering Foci of multiple myeloma were widely spread throughout the skeleton, and histologically were of the

A 5 15-31

B 6 6-31

C 7-20-31



E 4 20 32

D 4 20-32

F 5-30-32

Fig 2

From the antopsy report we merely state that a bronchopneumoma terminated plasma-cell type (Fig 10-C) There was a chronic nephritis, a pronounced arterio-

trachea This deviation was produced by a tumor in the thyroid region which showed irregular calcification Otherwise, no evidence of disease was discovered on physical and roentgenological search

Hematologic examination revealed a "moderate degenerative anemia of a hyperchromoligocythemmic type," furthermore, a "regenerative shift of the neutrophils with a low total count," and finally a "mild hyperbasophilia" After all medication had been discontinued for some time there remained in the hematologic picture a "mild secondary normocytic regenerative anemia" in the presence of a "normal total white count with moderate regenerative shift of the neutrophilic series" There was then a "persistent lymphocytopenia and mild eosinophilia" The impressions of the blood studies reported at this time were

"At present the blood picture presents a mild irritative hyper-regenerative picture affecting the neutrophils only The causative factors still present seem to be not of a septic nature, since a hyper-eosinophilia was observed The depression factor which influenced the hemoglobin and the red blood count levels seems to have been eliminated As a whole, the picture has improved"

Clinically we could not readily subscribe to the histologic diagnosis of lymphosarcoma for the following reasons The growth persisted for from 16 to 18 months without appreciable change It was not influenced at all by radiation therapy The presence of a tumor in the thyroid gland apparently had been entirely disregarded Therefore, we suggested for diagnostic consideration the presence of either a malignant tumor in the thyroid gland or derivation therefrom, with metastases to cervical lymph nodes

We communicated again with the pathologist who had submitted the original tissue diagnosis of lymphosarcoma of the reticular type and received the following information

"The tumor presents the appearance of a diffusely infiltrating mass, having the general appearance of alveolar reticulum-cell sarcoma However, the diagnosis of the small type cell

of thyroid carcinoma may be considered in view of the fact that this type of tumor has often in the past been confused with sarcoma. I am unable to be positive in the matter, but feel certain that it is either a reticulum cell sarcoma or a small-cell carcinoma of the thyroid"

Through the kind co-operation of this pathologist we obtained a stained tissue slide which was submitted to Dr Broders, pathologist to the Mayo Clinic He returned the diagnosis of plasma-cell myeloma After this information had been submitted to the patient he never returned for any further consultation We learned that he died approximately two years later, with the typical clinical manifestations of multiple myeloma

It is apparent from this unfortunately very incomplete case record that this type of disease does not always follow the generally accepted course, that a clinical diagnosis may be extremely difficult, particularly if highly trained pathologists render such varying opinions In this instance soft tissue manifestations—tumors—were the earliest signs of myeloma and lasted in rather stationary form from two to three years before generalized skeletal symptoms became apparent The sudden onset of the observed swelling, the presence of a tumor in the thyroid gland, the familial disposition to thyroid disease, the lack of response of manifest tumor masses to radiation, the absence of any of the clinical and roentgenologic conditions, on which a diagnosis of multiple myeloma might have been based—all these facts could hardly lead to a diagnosis such as finally was established from histologic examination of a biopsy

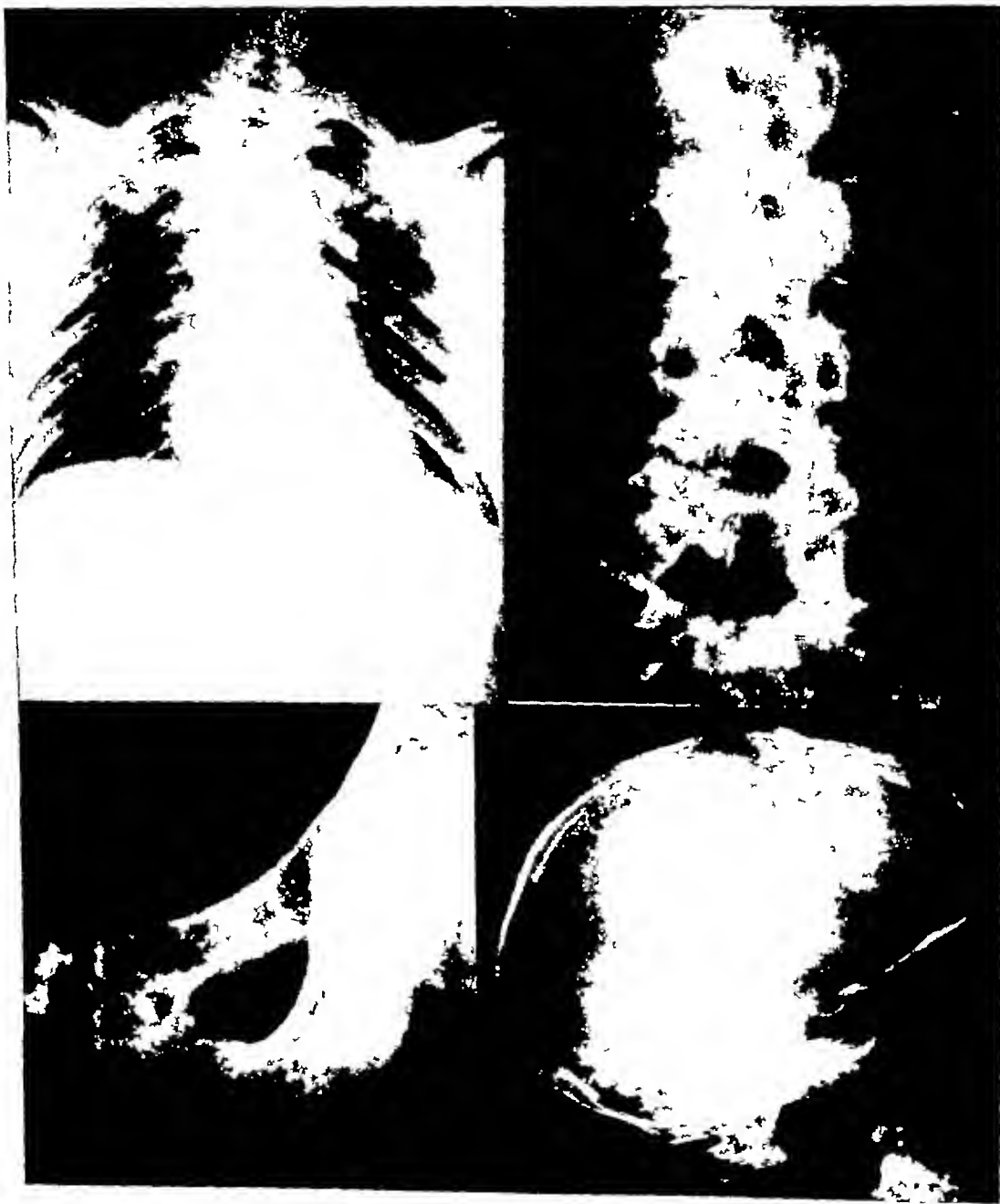
Geschickter and Copeland, in their book "Tumors of Bone," emphasize six conditions which, taken in pairs, triads, or collectively as a group, assume a diagnostic value of the first order, while in themselves they do not constitute conclusive evidence of multiple myeloma They are (1) multiple involvement of the skeletal trunk in an adult, (2) pathologic fracture of a rib, (3) the excretion of Bence-Jones bodies, (4) characteristic backache with signs of early paraplegia, (5) an otherwise inex-

Laboratory Findings—Hemoglobin varied from 32 to 62 per cent, with corresponding red counts of from 1,500,000 to

showed a relative lymphocytosis, occasionally up to 63 per cent, while the total count varied between 3,900 and

A 2-22-34

B 3-31-34



C 2-22-34

D 4-10-34

Fig 3

3 106,000 under the influence of repeated blood transfusions. The white count

6,850 cells per cubic millimeter. No Bence-Jones bodies were found in the

laminae of the seventh and eighth dorsal vertebrae were found to be involved by tumorous tissue [Dr E S Gurdjian] These laminae were removed and as much of the tumor, which was pressing against the spinal cord, as was compatible with careful work, was resected "

Histologic Report—The tissue is new-growth with a scanty, fibrous tissue stroma, trabecular in architecture The parenchyma is composed of somewhat anaplastic plasma cells, which vary in size somewhat but average ten to fifteen μ Some of them contain hyperchromatic nuclei and an occasional large prominent nucleolus is present Some cells appear as small lymphocytes There are many blood spaces and new blood vessels (See Fig 10-B)

Diagnosis—Plasma-cell myeloma (Dr C I Owen) This patient expired nearly ten and one-half months after admission Two months before his death no manifestations of myeloma could be discovered anywhere else in his skeleton Radiation treatment to the involved vertebra was without any demonstrable effect He grew weaker gradually and developed marked abdominal distention, with severe edema of his lower extremities, pain and sensory disturbances in the upper extremities Bence-Jones bodies were not found in his urine even at repeated examinations, nor was there ever recorded any evidence of nephritis in his urine though no blood chemistry was done An autopsy could not be secured

The available observations on this patient thus revealed backache, with signs of early paraplegia, and a multilocular destructive process in the body and laminae of the seventh dorsal vertebra, while all other evidence which might have supported a diagnosis of myeloma was missing This suggested diagnosis was confirmed histologically As far as we know, this patient did not develop grossly demonstrable myelomatous lesions anywhere else in his skeleton His death resembled that of myocardial failure Monostotic

manifestations of myeloma are quite rare though some apparently have been observed

Case No S2888, in contrast, represented the text-book picture described by Geschickter and Copeland The patient was a white male, aged 52, who complained three months prior to admission about rheumatic pains in the chest and back, improving under medical care On the day of admission, while riding in a street car, his thigh suddenly flexed without apparent cause under considerable pain

He had suffered from intestinal obstruction and peritonitis ten years previously He harbored lipomas in the right lower abdominal wall, and on the anterior surface of the right thigh Figures 2-A to 2-D show the appearance of the fractured right femoral shaft and its subsequent configuration during nearly one year From the appearance of the bone, with a central area of destruction and adjacent osteosclerosing reaction, a neoplasm was suspected immediately but for a short time the possibility of metastasis from a tumor of the urinary tract or the thyroid gland was entertained On further search of the skeleton, however, three weeks later other foci of bone tumors were found in ribs, lungs, and other skeletal segments, so that the diagnosis of multiple myeloma became quite apparent Two characteristic views of skull and femur (Figs 2-E and 2-F) illustrate the classical appearance of this widespread disease Radiation therapy was without any effect Bence-Jones bodies were found in the urine, together with albumin, about five months after admission and from then on till the patient's death Gradually increasing anemia was observed On a few occasions blood phosphorus was found to fluctuate between 3.7 and 4.4 milligrams per hundred cubic centimeters, while blood calcium fluctuated between 9 and 11.1 milligrams Increasing calcification of the arterial system was observed during his stay in the hospital, which is also apparent in the last roentgenogram of the fractured femur (Fig 2-D)

C I Owen following resection of a costal segment in which a lesion was quite apparent roentgenographically (Fig 10-D) This diagnosis had previously been suggested by Dr Howard P Doub, who had seen two similar patients After the first transfusion spleen and liver decreased in size, pain and tenderness disappeared, after the second transfusion the gums assumed a healthy appearance, no longer bled, and the patient felt fairly comfortable with but occasional tenderness in chest, sternum, and clavicle In this condition he left our institution and his family physician A consultant called by the family expressed the opinion that the serious diagnosis and prognosis pronounced on the basis of the studies recorded above were neither justified nor rational, and that he would cure this young man in a very short time However, we have definite information that he died after six weeks, following attempts at radiation therapy at another hospital

From the illustrations accompanying this paper it can be seen readily that bone lesions of chloroma resemble early foci of multiple myeloma The entire clinical picture, of course, is quite at variance

Tumors of bone occurring in multiple members of the same family are not observed frequently We record one such instance, as follows

Case No S4641 White female, aged 15 years, was hit on the lower part of the right thigh by a hard-pitched baseball, in September, 1931 One-quarter year later swelling occurred, with tenderness on use of the extremity and on pressure Distress was particularly annoying at night In May, 1932, when presenting herself at this institution, a tumor mass, hard to touch, and tender, about half the size of a large orange, was found over the inner right femoral condyle On roentgenographic examination a malignant osteogenic tumor was observed which we thought to represent a primary chondromyxosarcoma (Fig 4-1)

In June 1932, 15 x-ray treatments were given to the tumor area from two ports,

to a total of 2,700 r, employing the Pfahler technic No metastases were discovered anywhere Subsequent roentgenologic examination (Figs 4-B to 4-G) showed a continuous slow enlargement and expansion, culminating in an incomplete spontaneous fracture on Sept 27, 1932 On October 10, amputation was performed well above the tumor by Dr F H Purcell The histologic report follows

'Arising from the lower end of the femur is a newgrowth which is infiltrating the soft tissues It is lobulated, grayish-white in color, and measures $10 \times 8 \times 8$ centimeters in size It is attached to the femur by a broad base The bulk of the tumor is soft but spicules of bone are present "

Microscopic Findings—"The tumor tissue is highly vascular and cellular and contains small spindle cells to medium sized giant cells There is much variation in size and shape of nuclei, quantity of cytoplasm and in staining quality Many small areas of calcification are present "

Diagnosis—Osteogenic sarcoma of the femur ²

This patient is alive and well to-day without any evidence of metastases

About three years after we had first seen this girl her father presented himself, complaining of a tumor in the region of the manubrium sterni, and of pain in the back and legs A mass had been present in the sternal region for two months and was slowly enlarging Simultaneously lumbosacral backache became more intense Besides a severe oral sepsis there was found a firm mass about two and one-half inches in diameter, protruding from the lower part of the sternal manubrium Furthermore, on clinical examination the upper mediastinal area seemed widened to the left Roentgenologic examination of the chest (Fig 5) showed a lemon-sized tumor arising from the left hilum Structure of the thickened sternal manubrium appeared quite loosened up, honeycombed and there was a flat retrosternal soft tissue tumor A lumbosacral anomaly and some lumbar spondylitis, but no sign of tumor, was discovered in the spine ³ Radia-

² We regret that histologic sections of this growth are no longer available for illustration

sclerosis, and myocarditis. As stated above, this case offered a text-book picture of this skeletal disease, and the only one of the diagnostic symptoms missing was an early paraplegia, though it should be remembered that not all evidence developed simultaneously.

Very occasionally we encounter widespread manifestations of skeletal invasion by neoplastic disease which might resemble in their roentgenographic appearance early signs of multiple myeloma, that is, small rounded, somewhat carelessly punched-out-appearing bone defects, associated with an indefinite osteoporosis and somewhat irregular appearing architecture of the cancellous bone. We had occasion to observe one such patient for whom the final diagnosis of chloroma was definitely established from a lesion located in a resected costal segment. This patient's history is given herewith.

Case No 95214. White male, aged 21 years. The early history, as it was given to us, sounds somewhat fantastic. While being baptized, at the age of nine months, his right leg was struck against the baptismal font. That night a temperature of 105 degrees developed, with apparent pain and tenderness in the injured extremity. Following an expectant treatment for two months he was operated at a hospital in Albany, N. Y., and much pus evacuated. We learned by correspondence with this institution that a diagnosis of cellulitis of the leg and thigh was made. Following a convalescence of three months he began to walk at the age of fourteen months, when a right-sided lump was observed. At the age of five years he was injured in an automobile accident and received severe lacerations to the anterior surface of the right thigh. He was then in a hospital, the name and place of which he cannot remember, for ten weeks. At the age of eight years he had measles and pneumonia. At fifteen, he had a dry cough and pain in his anterior chest, but physical and roentgen examinations at that time revealed no evidence of disease, particularly no sign of

tuberculosis. For the past six or seven years he has had bleeding gums when biting apples or brushing his teeth.

In November, 1933, he complained of pain in the right side of his chest and epigastrium without cough or temperature. Since that time he had lost considerable weight. Later, distress developed in the right sacro-iliac region. By December the pain had become much worse and spread to his knees, hips, ankles, and fingers. It was quite intermittent in character. He was afflicted with marked anorexia and night sweats. The family physician, Dr. R. Q. DeTomas, saw him first in January, 1934, with the complaints mentioned. Under the diagnosis of rheumatic fever he was hospitalized toward the end of January and treatment with salicylates was instituted. Within a week he felt much improved and went home. However, two days later his pain returned. It was most marked at this time in the sacro-iliac areas, and the right upper abdominal quadrant. It was so severe that he had to be readmitted to the hospital.

Physical Examination—Weight approximately 90 pounds. Skin dry, eyes sunken, lips cracked and covered with dried blood from bleeding gums which were swollen and tender, especially along the dental margins. A chain of glands was felt in the posterior cervical region bilaterally. Small glands were palpated in either supraclavicular area, also the axillary nodes were slightly enlarged but not tender. On palpation considerable tenderness was elicited along the course of several ribs and on pressure over the costal arches, also under the left costal arch in the region of the spleen, which was palpable four fingers below the costal margin and two fingers from the midline. The liver was enlarged three fingers below the costal margin, less tender than the spleen. Both costal vertebral angles were quite tender. There were scars on the right hip and thigh. The right hip itself was extremely tender on palpation and motion. Otherwise, the physical examination revealed nothing of importance.

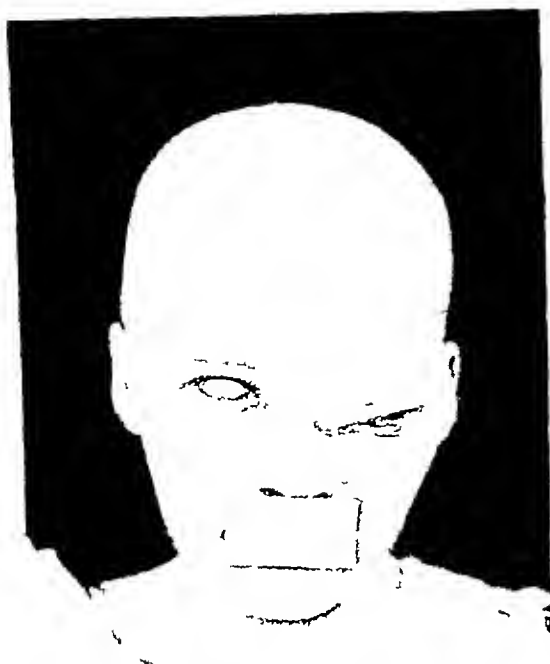


Fig 6

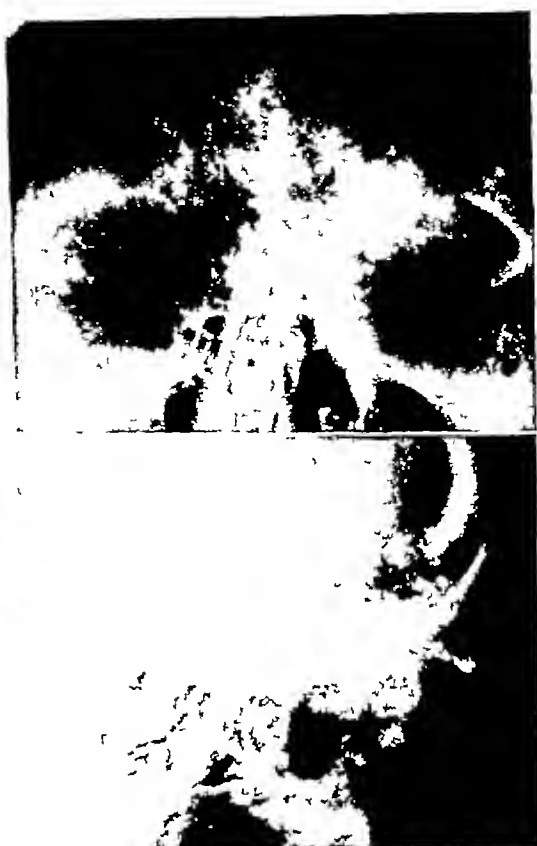


Fig 7

recognized in Figure 6, for which I am indebted to Dr Edgar A Kahn, of the Department of Neurosurgery at the University of Michigan

Roentgenographic examination revealed an osteogenic tumor of highly granulated appearance, filling practically the entire frontal sinus, destroying a considerable portion of the left orbital roof and invading the cranial cavity by destruction of the inner table of the frontal bone dorsomedially to the orbital roof. It also extended into the left upper anterior ethmoidal area (Fig 7). While we could not definitely identify this tumor, we suggested for differential diagnosis endothelioma and psammoma. Within a month's time it was apparent that in spite of radiation treatment—nearly 1,400 r were given to the tumor field from three ports or a total of 4,200 r during a period of three weeks—the neoplasm was enlarging in all directions.

Dr Gurdjian removed some of the tumor tissue for histologic investigation, Dr C I Owen reporting as follows:

"The specimen is composed of a small amount of well differentiated dense fibrous tissue and a parenchyma of a typical cartilage tissue. The cartilage tissue is highly cellular, somewhat undifferentiated, and the matrix is deeply stained. The exact degree of malignancy is not evident. These tumors recur on incomplete removal and become malignant at times. Diagnosis Chondroma."

This patient was transferred to the Department of Neurosurgery at the University of Michigan and for information on her subsequent fate I am indebted to Dr Edgar A Kahn. He reported that Dr Peet made an attempt to remove the huge tumor which projected out on the forehead and also invaded the various accessory sinuses. Grossly, he felt that he had succeeded, though it was an exceedingly radical operation. Dr Weller's report was osteochondrosarcoma, not sufficiently cellular to give rise to metastases. A recurrence took place a few months later.

urine, which was always negative for sugar and albumin except on three days of intense salicylate medication when a

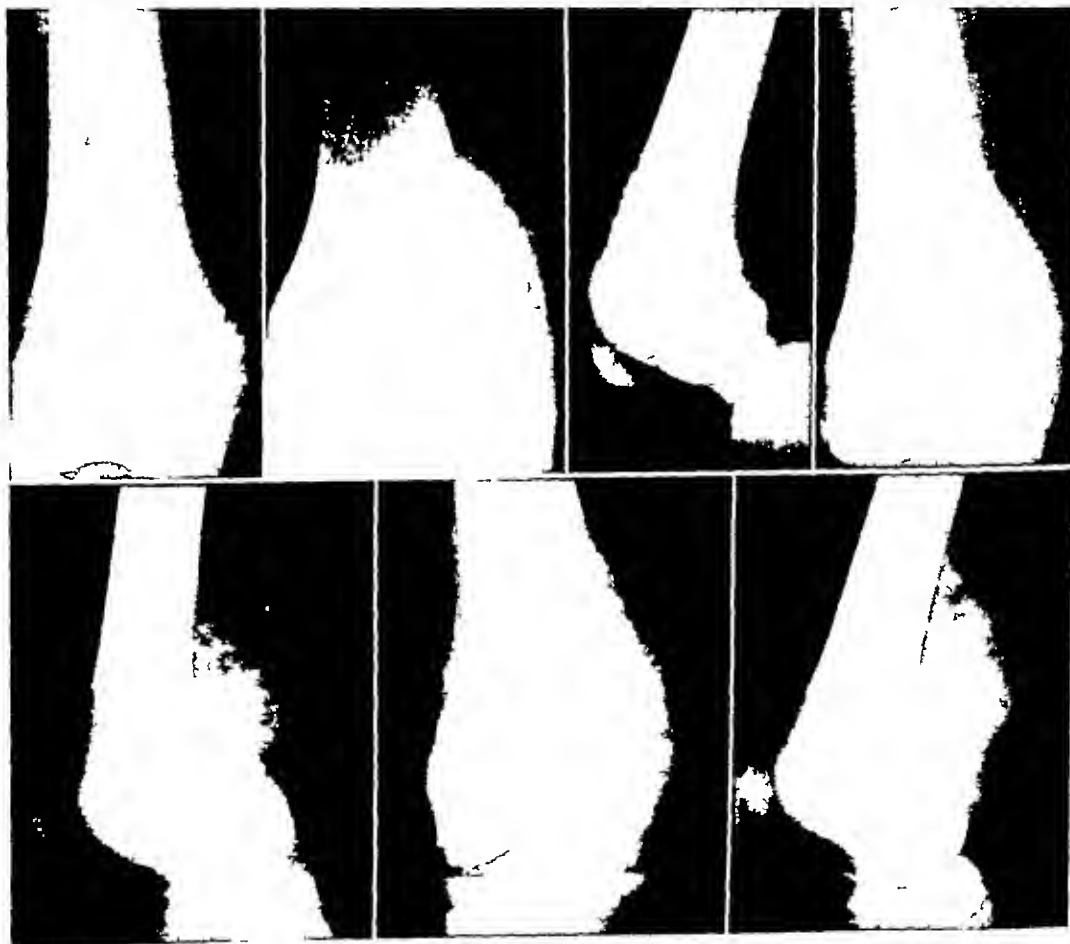
lary line. There was a severe left sacro iliac arthritis and of a less pronounced degree on the right side. Peculiar osseous deficiencies,

A 5-21-32

B 6-21-32

C 6-21-32

D 8-8-32



E 8-8-32

F 9-27-32

G 9-27-32

Fig 4

trace of sugar occurred. Occasionally hyaline and granular casts were observed in the urine.

From the x-ray studies we quote the following remarks:

"Bony structure throughout the thoracic cage and shoulder girdles appears somewhat irregular as if bone were extensively involved by a process producing a certain degree of osteoporosis with loose texture of cancellous bone and in certain parts small, ill-defined deficiencies, somewhat resembling small punched-out areas. Such a punched-out defect was found in the left seventh rib near the posterior axil-

as mentioned, were also found throughout the pelvis, especially in the ischial and pubic rami, furthermore, in the proximal portions of the femora and lumbar spine."

In April widespread similar foci were found in various bones of the facial skull and some also in the calvarium (Figs 3-A—3-D).¹

No radiation therapy was employed though a histologic diagnosis of chloroma (lymphoblastic type) was made by Dr

¹ See also Dr Shebesta's paper on mastoiditis in this issue.

Six months after the first examination metastases were found in the right ilium and also multiple metastatic nodules were

The difficulty of differentiation between osteomyelitis and endothelioma of bone has been pointed out repeatedly in the

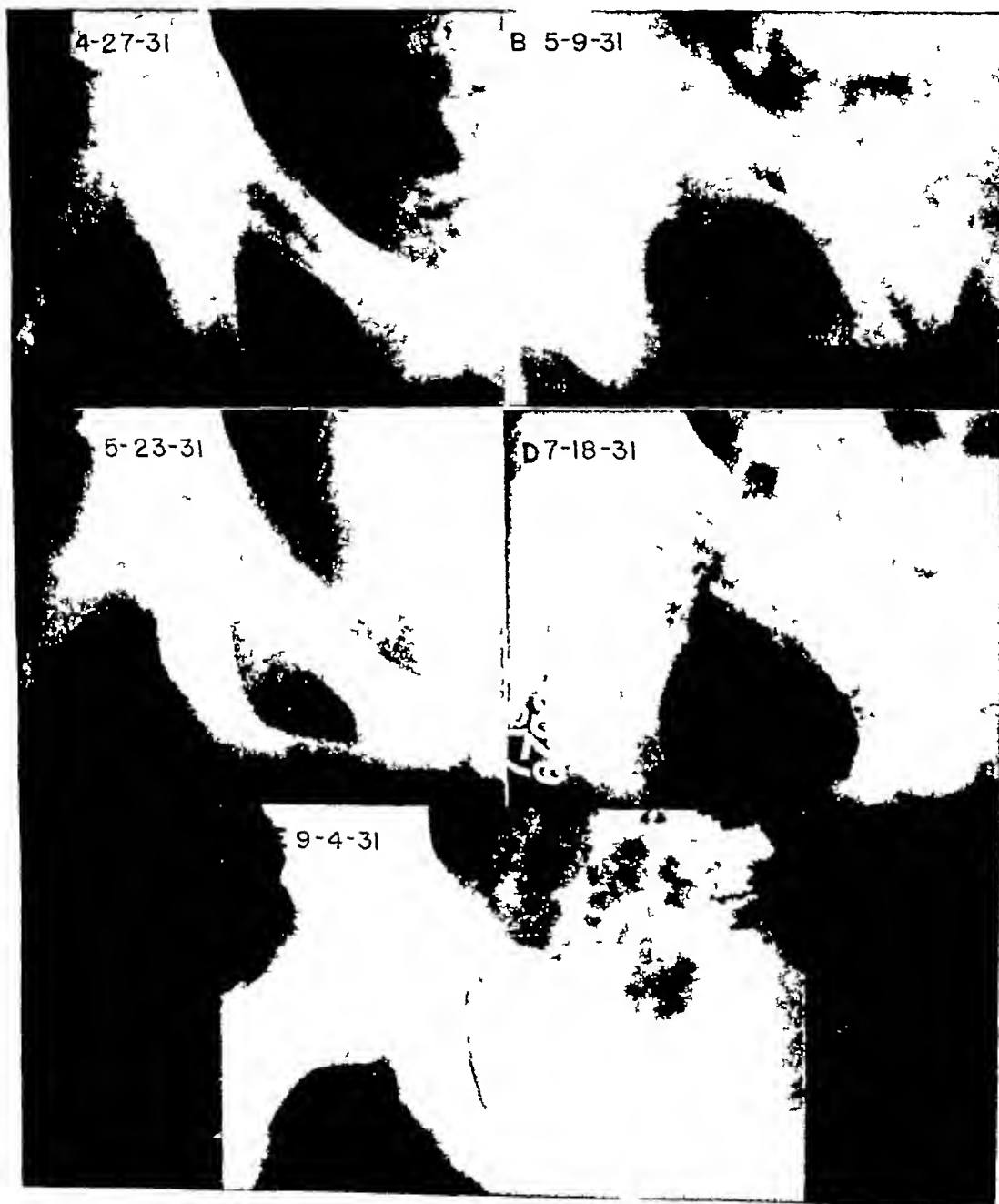


Fig 8

found in both lungs The patient died soon thereafter

literature Usually it is stated that this type of tumor responds readily to radiation



Fig 5

tion therapy was applied to the sternum and mediastinum from two ports for 23 days. A modified Coutard technic was used for a total of 5,340 r of heavily filtered radiation. During our observations no very material change occurred in the roentgen appearance of this patient's new-growth but arborization of the lung-fields became moderately intensified. This might have been the result of either radiation therapy or vascular stasis. During our observation this patient failed considerably and became quite irrational, so that he finally had to be transferred to the County Hospital. There a biopsy from the sternum was taken but proved unsatisfactory for histologic examination. A request for further study was refused by the patient, and he died six weeks after he had been seen by us for the first time. No autopsy was secured.

If we were inclined to accept case histories at their face value there would be no indication in either of these two patients' charts of the occurrence of an osseous neoplasm in multiple members of this family.

³ Roentgen records of the sternum are not suitable for reproduction.

It is not our intention to draw untenable conclusions from the results of the therapeutic measures employed. The difficulties in evaluation of case histories, particularly in regard to tendencies of inheritance, however, we want to stress—speculation as to possibly aggravated malignant tendencies in subsequent generations is left to the reader. We regret sincerely that material for a final histologic diagnosis in this last patient could not be secured, and probable metastasis to the brain could not be proven, as primary tumors of the sternum are extremely rare and metastases to this patient's brain were suspected from his behavior.

Primary osteogenic tumors of the cranium are quite rare. We report herewith an osteochondrosarcoma which during the time of its observation became decidedly more malignant in character and ultimately led to the patient's death.

Case No. 88258. White female, aged 21 years. From the past history one might merely mention that she had been afflicted repeatedly with sore throats and peritonsillar abscesses. She had also suffered from pleurisy two years prior to admission. When entering our institution she complained of headaches, which had prevailed for about one year. This distress was first localized to the frontal region but lately had been quite generalized throughout the head and occurred in increasingly frequent attacks and with more intense severity. One month prior to admission an itching sensation was noted to the left of the bridge of the nose in which region within a week a rapidly growing tumor developed, extending to the supra-orbital ridge and the upper left lid, thus somewhat impairing vision of the left eye. During the development of the growth dizziness became quite annoying, as it was sufficiently severe to prevent maintenance of erect posture. On the advice of a physician the patient had all upper teeth and all lower molars removed four weeks prior to admission in order to alleviate her headaches, and also underwent at the same time a tonsillectomy. The extent of the tumor can be

sequently exploration and curettage were performed (Dr D M Stiefel). He found a shiny, dome-shaped tumor of distinctly dark olive-green color. On incision there discharged under considerable pressure a material resembling pus mixed with blood and nondescript detritus.

Histologic Examination (Fig 10-G) — Dr C I Owen furnished the following

"The soft tissues are widely infiltrated with tumor tissue. This tumor tissue is composed of cells which in general are small, varying from small circular densely staining cells to small spindle cells with elongated nuclei. The bulk of them are the latter. It is a highly vascular tissue and includes much hemorrhage. There is a slight capillary architecture. Diagnosis: Ewing's tumor of the bone."

Two series of x-ray treatments were given. At first, 1,800 r of heavily filtered high voltage radiation was applied to each of two ports in twenty days. At the second series, a little over two months later, 1,500 r of heavily filtered high voltage radiation was applied to two ports each. At this time the patient was quite comfortable and was up and around. The response of the neoplasm to this radiation treatment is well shown in Figures 9-A-9-D, remarkable repair resulting in the invaded bone to an ultimate architecture almost resembling healing of the lesion.

In April, 1935, this boy returned to the hospital with pain in shoulders and chest. An increasing opacity of the right chest was observed, interpreted as a spreading bronchopneumonia with considerable congestion in the left lung. Roentgen examination of skull, shoulders, and mandible revealed no demonstrable evidence of invasion by neoplastic metastases. However the boy succumbed to his disease on May 28, 1935. No autopsy was obtained, therefore we could not ascertain presence or absence of pulmonary or other scattered metastases.

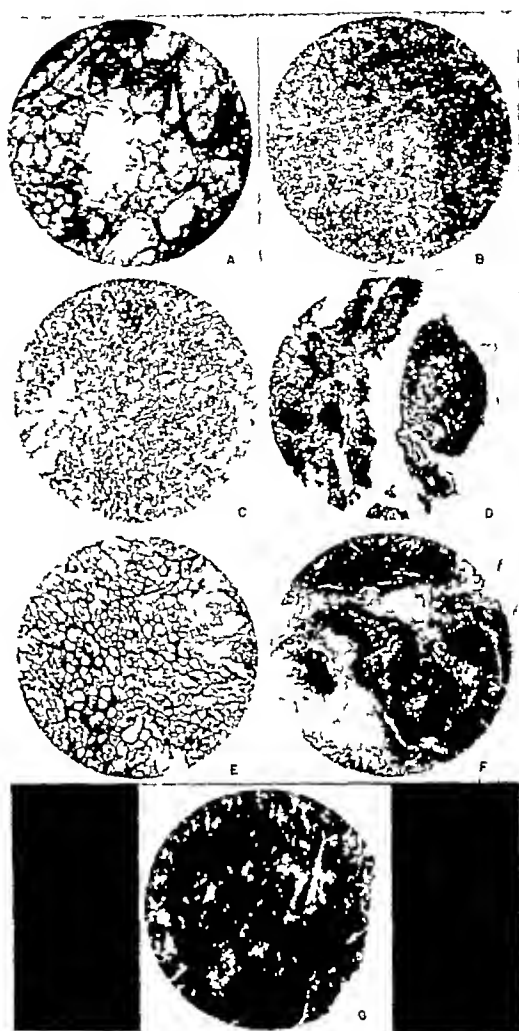


Fig 10

SUMMARY

Ten cases of neoplasm involving the skeleton are reported. One metastasizing adenoma of the thyroid, three multiple myelomas, one chloroma, one osteogenic sarcoma of the femur, one tumor of the sternum—not classified, one chondrosarcoma of the frontal bone, two endotheliomas of the pubic bone.

The noteworthy features of these cases are pointed out. Only one of these patients is surviving and apparently cured definitely.

and Dr Peet made another attempt to remove the tumor Dr Weller's report was osteochondrosarcoma, becoming progressively more cellular Dura and skin showed penetration at this time He stated that the neoplasm had reached the stage at which metastases might occur at any time Another operative attempt was made about eleven months after we had seen this patient first Then, the tumor, according to Dr Weller, had become even more cellular A large portion of the scalp was necessarily removed and it was hoped to obtain a granulating surface which might later be grafted The patient, however, died of meningitis a day or two later No autopsy was obtained

While from the original roentgenologic investigation we were not able to determine the type of tumor present, we felt from the beginning that it presented decidedly malignant characteristics The lack of response to rather intense radiation therapy should be noted and also the tendency to increasingly malignant characteristics in the histologic structure in spite of this radiation treatment

We know of but very few primary tumors involving the pubic bone and, therefore, record two nearly identical Ewing's tumors (endotheliomas)

Case No 10098 White female, aged 14 years⁴ The past history was entirely irrelevant For two months prior to admission this patient had noticed an ache in her right thigh which gradually became quite severe, so that she was unable to bear any weight on this leg No history of injury Examination revealed a slightly under-nourished, somewhat anemic looking young girl There was tenderness over the right pubic ramus and the femoral ring, while otherwise she seemed to be quite healthy Motion of the right hip was somewhat limited Blood count showed 7,400 white blood cells Tempera-

ture, 101 degrees, fluctuating later between 99 and 102 degrees From the original roentgenologic examination Dr Church reported as follows

"The upper right pelvic ramus showed some mottled rarefaction with apparent expansion of the bone and periosteal lines along both inferior and superior surfaces The acetabular cavity did not appear to be involved Probably a low-grade bone infection or possibly a Ewing's sarcoma The latter is a comparatively rare tumor and, therefore, it is much less likely than the former We cannot, however, rule it out with absolute certainty"

On subsequent examination it was apparent that a somewhat laminated appearance became more noticeable along the pubic ramus, while concurrently destruction increased, leaving a somewhat striated texture (Figs 8-A and 8-B) When we saw this patient I felt personally that an osteomyelitic process was more probable than an osseous neoplasm At the suggestion of Dr R H Stevens, radiation therapy was instituted Two series of treatments were given in two subsequent months, the first consisting of two ports to the tumor region, each receiving 1,000 r of heavily filtered radiation, while in the second series about 950 r of heavily filtered radiation was applied to identical ports The illustrations accompanying this article (Fig 8) show the response of the growth to radiation or, rather, the lack of response to the doses administered Subsequently Dr R G Owen submitted the following histologic report on a biopsy

"The entire mass of tissue consists of a new-growth composed of rather small polyhedral cells with deep-staining nuclei A moderate number of cells exhibit mitotic figures The cells in some areas show an alveolar type of arrangement, while other areas exhibit a definite peritheliomatous structure In still other places the cells lie in thin sheets, adherent to delicate connective tissue stroma There is considerable necrosis of the newgrowth in certain areas and in these places lymphocytic infiltration has occurred There is no evidence of differentiation toward cartilage or bone formation, nor are any giant-cell forms seen, Diagnosis Malignant sarcoma of bone (Ewing's sarcoma type)" See Fig 10 F

⁴ For much of the information concerning this patient I am indebted to Dr Church and Dr Poole of Pontiac Michigan who had this patient under observation at the Pontiac General Hospital

bone destruction? These questions can be answered more accurately by studying the temporal bone in more than one plane

a syndrome which is now known by his name The syndrome, associated with suppuration of the pars petrosa, consists of

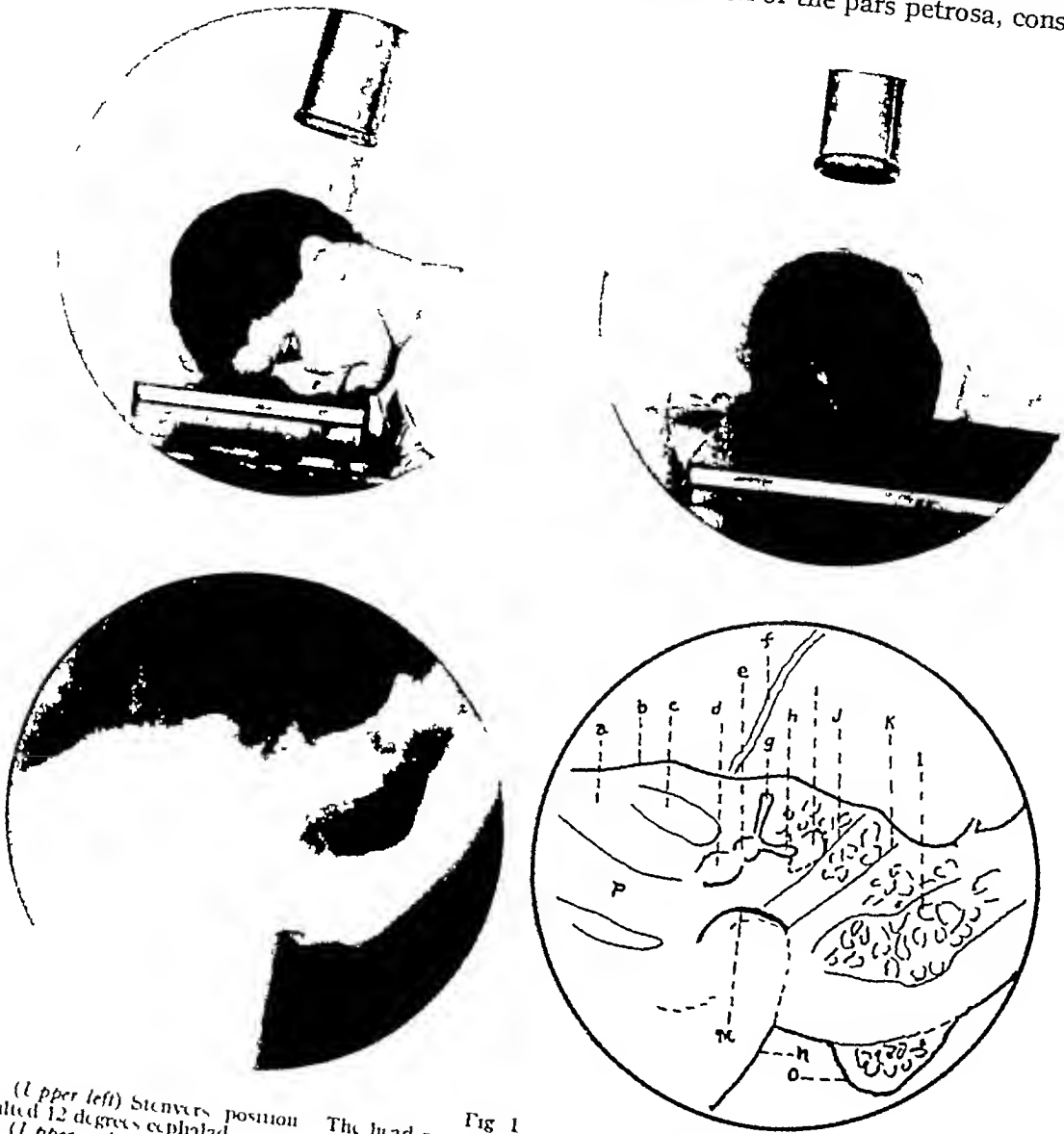


Fig 1

(Upper left) Stenvers position The head rests on the orbit nose and maxilla The roentgen tube is tilted 12 degrees cephalad
(Upper right) Stenvers position The sagittal plane of head is at a 45 degree angle to the cassette The rays traverse the pars petrosa perpendicularly
(Lower left) Stenvers view of a normal bone
(Lower right) Diagram of the roentgenogram (lower left) a Petrous apex b roof of petrous pyramid c middle meningeal artery marking d superior semicircular canal e horizontal semicircular canal f region of antrum g wall of lateral sinus h mastoid cells i temporomandibular joint j mandibular condyle k mastoid process l zygoma m external acoustic canal n vestibule o cochlea p internal acoustic canal

The greatest value in multiplane examination of the temporal bone is in the diagnosis of suppuration in the pars petrosa. As early as 1904 Gridelmo (7) described

sixth nerve paralysis, fifth nerve pain and a discharging ear. However, it was not until after the excellent papers of Kopetzky, Almour, Eagleton, Profant, and Tay-

therapy of moderate intensity. Such was not the case in this instance as is apparent from the illustrations

was negative except for the presence of two masses in the right groin below Poupart's ligament and under the sartorius muscle

A 6-19-34

B 8-7-34



C 12-8-34

D 1-5-35

Fig 9

About three years later an almost identical case came under our observation

Case No 9426 White male, 12 years of age, complaining of rheumatic pain in the right leg for the last month, during which period also a growth in the right groin appeared which had been receding somewhat in size of late. There was no history of injury. Physical examination

Tuberculin tests were negative, tests for syphilis were negative. Blood count showed 3,400,000 red blood cells, 10,000 white blood cells, 70 per cent polymorphonuclears, 28 per cent mononuclears. Urinalysis was negative. Temperature was almost normal. The roentgenologic diagnosis of a Ewing's tumor was made from the first examination (Fig 9-A). Sub-

bone formation found in the pars petrosa does not necessarily parallel that of the mastoid portion. Belinoff and Balan (1) myelitis. However, petrositis is most commonly found in pneumatized bone. Routine examination of the pars petrosa

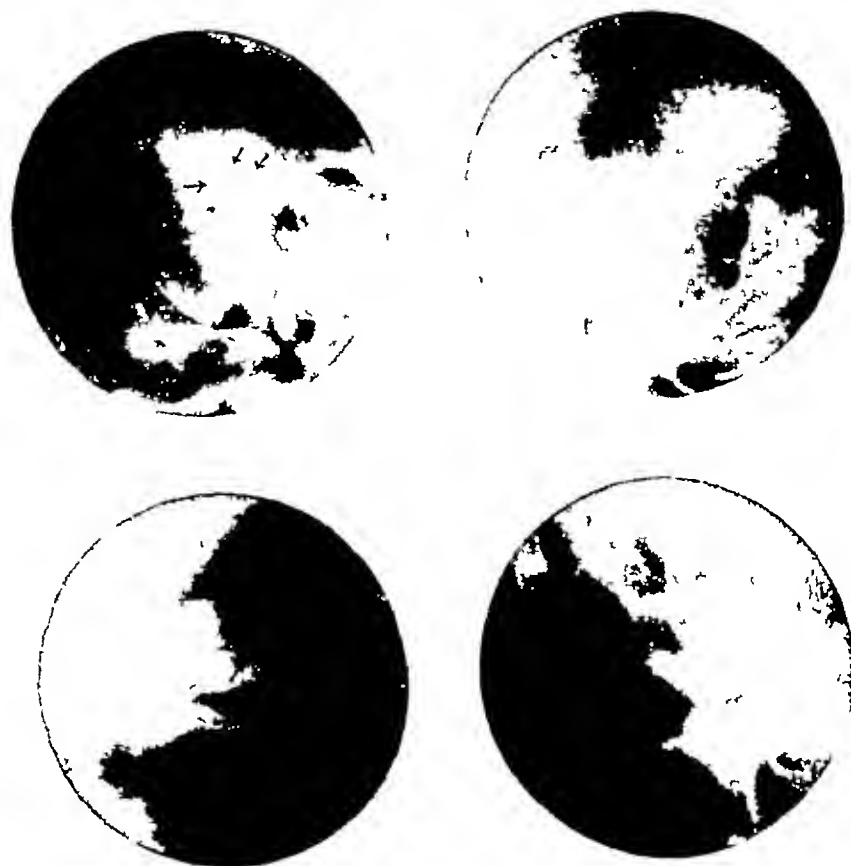


Fig 3

(Upper left) Notice the large defect which was produced by a cholesteatoma (Law-Schüller projection)

(Upper right) The opposite mastoid. Notice the difference in pneumatization between the two mastoids of the same patient

(Lower left) Same region as in previous view (Stenvers projection). Notice the cholesteatoma. The depth at which the surgeon shall find it is clearly demonstrated. Notice the slight degree of pneumatization

(Lower right) The opposite mastoid. A lighter exposure is required to demonstrate the mastoid process

found the two portions the same in 37.5 per cent of 40 temporal bones studied. The types of bone formation found by them were 35 per cent pneumatic, 22.5 per cent diploic, and 42.5 per cent contained mixed cells. Other authors have found relatively similar findings, but Profant believes the cell formation is similar in the two portions of the temporal bone.

Petrositis may occur irrespective of the cell formation. When the pars petrosa is not pneumatized the process is an osteo-

is urged in order to recognize an early case of petrositis as well as to furnish a control roentgenogram if later complications arise. The roentgen findings of petrositis are similar to those of mastoiditis, namely, cloudiness followed by evidence of cell erosion and later evidence of abscess formation, sclerotic changes, or—in advanced cases—complete disappearance of the contour of the petrous apex. Usually some clouding is noted in the pars petrosa accompanying a simple mastoiditis. Kopet-

TEMPORAL BONE STUDIES

By E M SHEBESTA, M D , *Detroit, Michigan*

From the Radiologic Services of R H Stevens, M D , H A Jarre, M D , and
C K Hasley, M D , Grace Hospital

TECHNICAL CONSIDERATIONS

IT IS our impression that there are still too few roentgenologists who routinely examine the mastoid region in more than one plane it is this fact which prompts the writing of this paper No other bone in the body is studied in only one plane, and a bone as anatomically complex as the temporal bone should be no exception

The following men have described positions to be used in the examination of the temporal bone Law, Schuller, Stenvers, Taylor, Chamberlain, Henle, Lange, Sonnenkalb, Feretti, Fisher-Sgalitzer, Busch, Mayer, Groshey, Staunig, Graupner, Kuhne and Plagemen, Lysholm, Low-Beer, Hasselwander, Hirsh, and others At least 24 different projections have been described When the roentgenologist is confronted with this multitude of projections he naturally is bewildered Most of us are agreed on the Law-Schuller projection as a necessity the confusion arises when the other planes are to be employed Several of the advocated projections are useful in demonstrating some particular involvement of the temporal bone such as acoustic nerve tumor, disease of the mastoid tip, etc Some of the objections to the different methods are complex technic, distortion, and discomfort to the patient

Roentgenologists need not concern themselves with the multitude of methods for rarely does one need roentgenograms made in more than two planes for the same reason that we use only these two planes in studying other bones We, therefore, routinely employ the usual Law-Schüller projection and the Stenvers' projection These two methods enable one to view the temporal bone in the postero-anterior and lateral planes and only very rarely do we use the mento-vertex or vertex-mental projec-

tion In the examination of the pars petrosa, the Stenvers' view (see Fig 1) is the most widely used in Europe and is gaining popularity in this country very rapidly The Stenvers' view demonstrates all the essential anatomy of the pars petrosa as well as the minute structures of the middle ear with the least amount of distortion Our technicians have had no difficulty with this method If one wishes to simplify the technic he can use the device recommended by Sussman (19), or the Camp and Gianturco localizer It is well to remember that the mastoid tip and the lateral portion of the mastoid are less radio-opaque than the pars petrosa, and consequently when we are particularly interested in this region we reduce the exposure approximately 25 per cent By using stronger illumination this additional exposure is usually not necessary We have not found the Potter-Bucky diaphragm essential Likewise, no special means of immobilizing the head are required if a short exposure can be used A fine focus tube and a small cone are highly desirable

ROENTGEN INTERPRETATION

The roentgenologist should be prepared to answer the following questions Is the mastoid process cellular or non-cellular, is there evidence of cell destruction, is there evidence of softening of the bone if a previous operation has been performed, how much of the cell structure remains, what is the position of the mastoid foramen, is there any evidence of tumor involving the temporal bone, what relation does the lateral sinus bear to the affected region, what is the extent of pneumatization of the petrous bone, does the infectious process involve the petrous bone, and if so, is there evidence of suppuration and

ticles of Eagleton, Kopetzky and Almour. However, very close co-operation between the otologist and roentgenologist is neces-

structure, and acoustic nerve and cerebello-pontine angle tumors. Acoustic nerve tumor produces an enlarged internal audi-



Fig 5

(Upper left) Stenvers projection showing otitis media and early destructive mastoiditis

(Upper right) Same case but the opposite side showing also a mastoiditis as well as an early petrositis (Cerebro-spinal fluid showed increased cell count and later also streptococci)

(Lower left) A case of sclerosing petrositis

(Lower right) Another case showing marked destruction in the petrous apex. Notice the probe in the apex

sary since early operative treatment occasionally will prevent a fatal meningitis, and occasionally an unnecessary operation may be avoided since many cases of petrositis clear up spontaneously.

Other conditions which may be demonstrated by multiple examinations are periostitis of the mastoid process with pus between the bone and periosteum, swelling of the external ear resulting from furunculosis of the external auditory canal, Bezold mastoid with perforation of the tip, necrosed bone covered by normal cell

tory meatus with surrounding rarefaction. In one of our cases (Fig 2) we incorrectly diagnosed petrositis, and at autopsy a meningioma was found producing the osteonecrosis of the pars petrosa. This case, however, previously had had mastoiditis, and at the time of the roentgen examination she had diplopia, pain in the ear, and purulent discharge from the ear, all of which are typical symptoms of petrositis. Petrous ridge deformities may also result from cerebello-pontine angle tumors as pointed out by Pancoast (15).

lor, in 1930 and 1931, that suppuration of the pars petrosa was diagnosed prior to autopsy except in rare instances Profant

"(1) *The 'antrum epitympanic route'*—The cells extend from the antrum and epitympanic spaces above the cochlea, and above and be

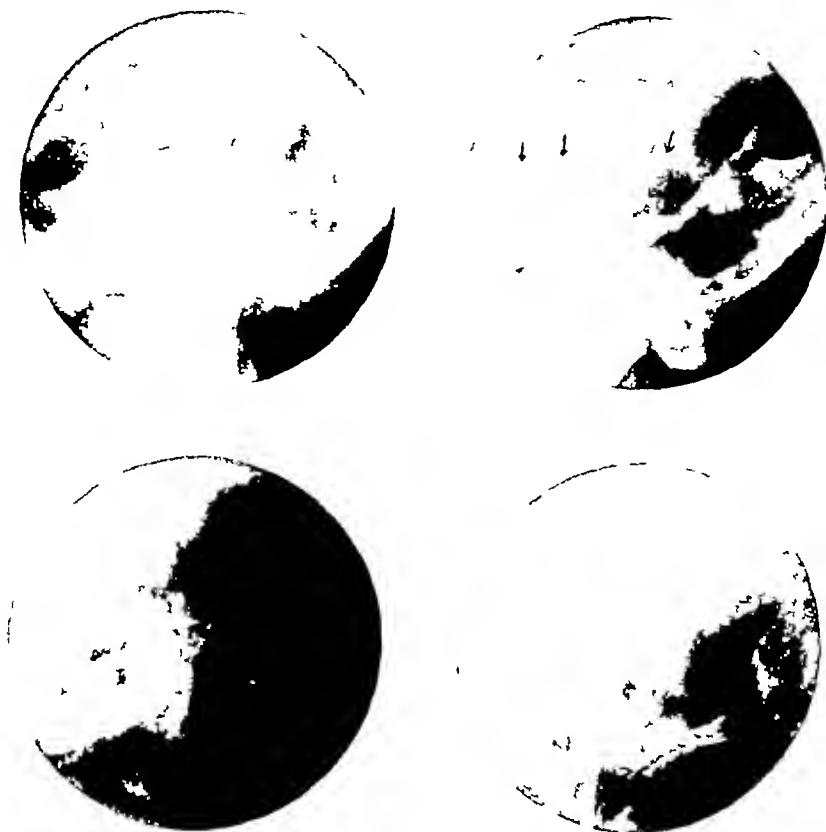


Fig 2

(Upper left) Normal side
(Upper right) Pathological side Notice the marked destruction of the petrous ridge and petrous apex The clinical and roentgenologic diagnosis was petrositis Six weeks prior to these studies a mastoidectomy was performed with positive findings of mastoiditis At autopsy a meningioma was discovered
(Lower left) Law-Schüller projection showing destructive mastoiditis, but the perforation is not demonstrated
(Lower right) Stenvers' projection showing the mastoiditis as well as the perforation

(17), in 1930, read at the American Medical Association meeting a paper on Gradenigo's syndrome, at which time he suggested the use of the term "petrositis" He had dissected the temporal bones of five-, six-, and seven-month fetuses, two full-term infants, and 100 adults, finding three types of bone formation (1) compact or sclerotic, (2) spongy or cancellous, and (3) cellular Profant also studied the routes of infection in cases of petrositis and concluded that there are two routes

hind the superior semicircular canals, then behind, above, and in front of the internal auditory meatus, and finally to the mass of cells under the tegmen of the anterior surface of the tip

"(2) *The 'hypotympanic route'*—The cells extend from the hypotympanic space below the cochlea, then below the internal auditory meatus, and finally to the mass of cells under the tegmen of the posterior surface of the tip"

Heretofore the four routes described by Perkins have been generally accepted

It is well to remember that the type of

CONGENITAL BONE DYSPLASIA

B₃ SYLVESTER FORD, M D, *Detroit, Mich*

HERE is probably no tissue in which the histological picture is more complicated than that of the osseous system. During the life of the individual there is a constant metaplasia, each phase of which may proceed at different rates during different periods.

This makes possible an infinite number of pathologic changes, depending on the phase of bone growth affected, the period at which this takes place, and the degree and type of histopathologic change. Similar etiological factors may cause widely different conditions as seen clinically, microscopically, or radiographically.

It is not difficult to understand, therefore, that in reviewing any group of pathologic bone conditions one is confronted with a complexity of nomenclature and classification. This is especially so in dealing with the bone dysplasias as little, if anything, is definitely known concerning the etiology of those conditions. There is no general agreement except that the conditions are not tuberculous, rachitic, or syphilitic, but rather congenital, with some types showing definite hereditary tendencies.

The congenital bone dysplasias can be roughly divided into two main groups, (1) the malacic, in which the predominant characteristic is a deficiency in sub-periosteal bone production with a resultant softening and osteoporosis, and (2) the hyperostotic in which there is over-production of cortical bone.

Osteogenesis imperfecta—This condition is classified as a myeloplastic malacia by Hirsch (6) in his modification of von Recklinghausen's classification of the malacias. Two forms of *osteogenesis imperfecta* are generally recognized, depending on the age at which the condition appears.

Osteogenesis imperfecta congenita—First described by Vrolik, in 1849, numerous cases have been reported of this interesting

condition. It is characterized by multiple fractures which show evidence of healing *in utero*. The long bones, ribs, and clavicles are most often affected. The very thin cranial and pelvic bones are poorly developed and all the bones show osteoporosis to a more or less marked degree.

The disease is incompatible with life, most patients surviving only a few hours. Some have been reported as living as long as two or three weeks. The infants are always born to normal parents and the most plausible cause for the disease appears to be a primary defect of the mesenchyme, as held by Weber (13). An interesting case has been reported by Welz and Lieberman (14), as occurring in single ovum twins.

These authors and others have investigated the blood chemistry in the patient and parents and find no variation from the normal. Wyatt and McEachern (16) have reported unusual vascularity of the parathyroids in one case. An endocrine etiology is generally considered, however, to be purely an assumption, as this is the only instance in which any of the endocrine glands have been discovered to be abnormal.

The author's case (Fig. 1) demonstrates the typical multiple fractures, most of which show evidence of healing *in utero*. Also to be noted is the thickening and shortening of the long bones, described by Fairbank (2) as Type I. The cranial bones are extremely thin, although the pelvic bones do not show this characteristic to any great extent.

The history in this case is also typical of that usually reported. The mother was a primipara, 20 years of age, apparently in excellent health, and the puerperium was uneventful and of normal duration. Delivery was by breach, as is almost invariably the case, and the infant expired in less than one hour. The maternal and

Fig 4

(*Upper left*) Early destructive mastoiditis (Stenvers projection)
 (*Upper right*) Same region 30 days post-operatively Notice the post-operative
 defect as well as destruction in the petrous pyramid
 (*Lower left*) Another case Notice the defect in the petrous apex as well as de-
 structive mastoiditis (Stenvers projection) Notice the numerous punched
 (*Lower right*) Stenvers view of another case Notice the chloromatous foci
 out ' defects in the temporal bone which were proven to be chloromatous foci
 Other parts of the skeleton were also involved (See Dr H A Jarre's article in this
 issue)

stilled through the fistulous tract or through a drill hole made by the Almour operation This appears to be the only way to demonstrate perforation of the petrous apex

The clinical findings of petrositis will be discussed briefly Gradengo's syndrome is not a common finding in petrositis In a series of 15 cases observed by Kopetzky and Almour, only two cases showed sixth nerve paralysis Abductor nerve paralysis is due to disease of a pneumatized pars

tribution of these nerves is a much more important sign The eighth nerve is also frequently involved All these nerves are in close proximity to the pars petrosa and are affected by the neighboring swelling and congestion The most frequent findings are low grade sepsis, otorrhea, retro-orbital pain, and occasionally sixth nerve paralysis These findings usually occur several weeks following a mastoidectomy Those who are interested in the treatment of petrositis are referred to the ar-

ten Healing takes place rapidly, and there is often considerable deformity, due to malunion

The roentgen findings are similar to those seen in osteogenesis imperfecta congenita. There is a high degree of osteoporosis and the cortex is very thin and deficient in lime salts. The long bones, however, tend to be long and narrow—Fairbank Type II—and show deformities from malunion of previous fractures

There appear to be two types of osteogenesis imperfecta tarda (1) The idiopathic, or non-hereditary, and (2) the hereditary type in which the condition is part of a syndrome in which the presence of blue sclera is a dominant characteristic

The latter condition was first described by Spurway (12), in 1896, and has since been frequently discussed, usually under the head of "brittle bones and blue sclera." Because of its hereditary nature and the fact that structures derived from the mesenchyme are primarily affected, Key (9) prefers the term "hereditary hypoplasia of the mesenchyme."

If the disease is due to a primary defect in the mesenchyme, the question arises as to why all the tissues derived from this structure are not affected. Shugrue (11) states that probably all these tissues are involved to a varying degree with the more highly organized group comprising the bones, cartilage, and tooth pulp showing the greatest disturbances

Blue sclera is a dominant characteristic and is always present, both in the patient himself and in one of his parents. There is no skipping of generations. Associated with this, one may or may not have any or all of the following

- (1) Multiple fractures—70 per cent cases
- (2) Deafness. This is of the otosclerotic type and does not appear until later in life, usually about the twentieth year. For this reason, it has probably not been reported as often as it actually occurs
- (3) Loose joints and frequent dislocations and sprains due to laxness of the fibrous structures of the body

The treatment of cases of osteogenesis

imperfecta tarda, either of the hereditary or idiopathic type, is, of course, symptomatic with special attention given to proper alignment of fractured bones and precautionary measures to avoid new fractures. Hansen (4) reports a thorough study of the mineral metabolism in two patients to whom large doses of viosterol and parathyroid extract were administered. He concludes that "while it cannot be concluded that hyperfunction of the parathyroid is a factor in osteogenesis imperfecta, it is obvious that large doses of viosterol or parathyroid extract only accentuate the condition already present in mineral metabolism and are contra-indicated as therapeutic agents in this condition."

Osteitis fibrosa and osteitis deformans—Although the *osteitis fibrosa* of von Recklinghausen and the *osteitis deformans* of Paget are generally recognized as two distinct disease entities, nevertheless the pathological processes are fundamentally similar. These consist of fibro-osteoid change, malacia, giant-cell tumor formation, and hyperostosis

Osteitis fibrosa is generally conceded to be a congenital bone dysplasia with relatively strong hereditary tendencies. In his comprehensive work covering this condition, Hirsch (5, 6, 7) states that here also a congenital weakness of the mesenchymal tissues may well be the underlying cause. Lesions of the parathyroids have been suggested as a possible etiological factor, but as yet there is little to substantiate this assumption

Osteitis deformans is regarded as an affliction of later life. This is probably due, in part, to the fact that the condition is not usually recognized until deformities present themselves. The progress is slow, the symptoms are few, and the patient does not become concerned until noticeable deformities have developed. There appears to be an hereditary tendency and, if so, the changes have possibly been slowly progressing even since birth. The lesions may possibly have been present in childhood in the form of a mild and hence unrecognized form of osteitis fibrosa

zky, Almour, and Taylor have found the petrosa in the region of Dorello's canal through which the nerve passes. Ocular injection of Ipiodol helpful in studying the diseased pars petrosa. The Ipiodol is in-



tomless and is only discovered during the course of roentgenographic examination for other causes

SUMMARY

At present we must be satisfied by assuming that factors of unknown etiology disturb the delicate balance between bone absorption and new bone formation to produce the various bone dysplasias. Regardless of the etiology, it is evident that these factors may be present in early intra-uterine life and in some instances, at least, are definitely hereditary. The prevailing pathologic changes are those of increased bone absorption and faulty bone regeneration, whereas the osteopathies which are characterized by excess production of cortical bone comprise only a small group of extremely rare conditions. The following classification is suggested

Malacic

- 1 Osteogenesis imperfecta congenita
- 2 Osteogenesis imperfecta tarda
 - (a) Non-hereditary or idiopathic
 - (b) Hereditary, associated with blue sclera
- 3 Osteitis fibrosa cystica
- 4 Osteitis deformans
- 5 Possibly osteochondritis

Hyperostotic

- 1 Marble bones
- 2 Melorheostosis Léri
- 3 Osteopoikilosis

The influence of the endocrine glands, especially the parathyroids and pituitary,

upon bone growth is well recognized, but there is nothing to substantiate the belief that the congenital bone dysplasias are manifestations of endocrine dysfunction. Careful studies of mineral metabolism have failed to elicit any conclusive results.

A case of osteogenesis imperfecta congenita is reported, the various bone dysplasias of congenital nature are discussed, and an attempt is made at classification of these conditions.

BIBLIOGRAPHY

- (1) CHRISTIE, A. C. Osteochondritis or Epiphyseitis. *Jour Am Med Assn*, 1926, 87, 291
- (2) FAIRBANK, H. A. T. Some Remarks on Osteogenesis Imperfecta. *Proc Royal Soc Med*, July, 1930, 23, 77-84
- (3) GOIN, L. S. Idiopathic Osteopsathyrosis. *Am Jour Cancer*, March, 1933, 17, 668-681
- (4) HANSEN, A. E. Influence of Viosterol and Parathyroid Extract on Mineral Metabolism in Osteogenesis Imperfecta. *Am Jour Dis Child*, July, 1935, 50, 132-157
- (5) HIRSCH, I. S. Is Generalized Osteitis Fibrosa Congenital? *Am Jour Surg*, 1927, 3, 167
- (6 and 7) Idem. Generalized Osteitis Fibrosa. *RADIOLOGY*, June, 1929, 12, 505-516, July, 1929, 13, 44-84
- (8) KARSHNER, R. G. Osteopetrosis. *Am Jour Roentgenol and Rad Ther*, 1926, 16, 405
- (9) KEY, J. A. Brittle Bones and Blue Sclera. *Arch Surg*, 1926, 13, 523
- (10) KRAFT, E. Melorheostosis Léri. A Flowing Hyperostosis of a Single Extremity. *Jour Am Med Assn*, Feb 27 1932, 98, 705-709
- (11) SHUGRUE, J. J., et al. Fragilitas Ossium and Deafness. *Arch Int Med*, 1927, 39, 98
- (12) SPURWAY, J. Hereditary Tendency to Fracture. *British Med Jour*, 1896, 2, 845
- (13) WEBER, M. Osteogenesis Imperfecta Congenita. Study of Its Histopathogenesis. *Arch Path*, May 1930, 9, 984-1006
- (14) WELZ, W. E., and LIEBERMAN, B. L. Report of a Case of Osteogenesis Imperfecta in Twins. *Am Jour Obst and Gynec*, 1927, 14, 49
- (15) WILCOX, L. F. Osteopoikilosis. *Am Jour Roentgenol and Rad Ther*, April 1932, 27, 580-584
- (16) WYATT, T. C., and MCEACHERN, T. H. Congenital Bone Dysplasia (Osteogenesis Imperfecta) Associated with Lesions of the Parathyroid Glands. *Am Jour Dis Child*, February, 1932, 43, 403-415

SUMMARY

1 Temporal bone examination is in a state of confusion and a more uniform practical method is highly desirable

2 Routine examination of the temporal bone in more than one plane is strongly urged

3 Several illustrative roentgenograms are presented

I wish to express my appreciation to Dr Hans A. Jarre for his valuable assistance

REFERENCES

- (1) BELINOFF and BALAN, M. Ueber den Bau der Pyramidenspitze. *Monatschr. f. Ohrenh.* October 1930, 64, 1185-1188
- (2) EAGLETON W. P. Localized Bulbar Cisterna (Pontile) Meningitis. Facial Pain and Sixth Nerve Paralysis and Their Relation to Caries of the Petrous Apex. *Arch. Surg.* March, 1930, 20, 386-420
- (3) Idem. Meningitis—The Result of Disease of the Petrous Apex and Sphenoidal Basis. *Surg., Gynec. and Obst.*, February (No. 2A) 1935, 60, 586-587
- (4) EBENIUS, BERTIE. The Results of Examination of the Petrous Bone in Auditory Nerve Tumors. *Acta Radiol.* 1934, 15, 284-290
- (5) FREEDMAN, EUGENE. Radiography of the Petrous Bone. *Radiog. and Clin. Photog.* March, 1936, 12, 10
- (6) FUCHS, A. W. Radiography of the Temporal Bone. *Radiog. and Clin. Photog.*, September 1935, 11, 2
- (7) GRADENIGO, G. Über Circumscripte Leptomeningitis mit Spinalen Symptomen und über Paralyse des N. Abducens Otitischen Ursprungs. *Arch. f. Ohren-, Nasen- u. Kehlkopfch.* 1904, 62, 255
- (8) GEYMAN, MILTON J. and CLARK, DANIEL M. The Roentgen Demonstration of Petrositis. *Acta Radiol.* 1932, 13, 125-133
- (9) GRANGER, A. Roentgen Examination of Paranasal Sinuses and Mastoids. *Jour. Am. Med. Assn.* Nov. 1, 1930, 95, 1332-1335
- (10) JUNGERT, Y. Einiges über das Syndroma Gradenigo und die Erfahrungen darüber an der Klinik auf Sabbatsberg. *Acta Oto-laryng.* 1931, 16, 394-403
- (11) KOCH, C. E. Objective Otologic Roentgen Stereoscopy and its Significance for the Roentgen Diagnosis of Diseases of the Mastoid Process. *RADIOLOGY*, July 1934, 23, 75-79
- (12) KOPETZKY, S. J., and ALMOUR, R. Suppuration of the Petrous Pyramid, Pathology, Symptomatology, and Surgical Treatment (Parts 1 and 2). *Ann. Otol. Rhinol. and Laryngol.* December, 1930, 39, 996 and March, 1931, 40, 157
- (13) LAW, FREDERICK M. Roentgen Examination of the Mastoid Processes. *Am. Jour. Roentgenol. and Rad. Ther.*, April 1934, 31, 482-486
- (14) MAYER, G. *Otologische Röntgendeaquistik*. Second ed., Julius Springer 1930
- (15) PANCOAST, H. K. The Significance of Petrous Ridge Deformation in the Roentgen ray Diagnosis and Localization of Brain Tumors. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1928, 20, 201-208
- (16) PERKINS, C. E. Abducens Paralysis and Otitis Media Purulenta. *Ann. Otol. Rhinol. and Laryngol.* 1910, 19, 692
- (17) PROFANT, H. J. Gradenigo's Syndrome with a Consideration of Petrositis. *Arch. Otolaryngol.* March, 1931, 13, 347-378
- (18) STENVERS, H. W. Roentgenology of the Os Petrosum. *Arch. Radiol. and Electrol.* September 1917, 22, 97
- (19) SUSSMAN, M. L. Simple Technic for Roentgen Examination of Petrous Pyramid. *Am. Jour. Roentgenol. and Rad. Ther.*, September 1933, 30, 415-418
- (20) TAYLOR, H. K. The Roentgen Findings in Suppuration of the Petrous Apex. *Ann. Otol. Rhinol. and Laryngol.*, June, 1931, 40, 367-395
- (21) Idem. Roentgen Findings in Suppuration of Petrous Apex (Petrositis). *Am. Jour. Roentgenol. and Rad. Ther.* August 1933, 30, 156-162
- (22) Idem. Suppuration in the Pneumatic Petrous Apex. *Am. Jour. Roentgenol. and Rad. Ther.*, June, 1935, 33, 767-773

the occurrence of pain brings him to a physician. In four, or 33 per cent of our cases, pain was part of the symptomatology. In one case a severe neuritis due to spinal metastases was the prominent feature of the case from the time of the first observation. Deep-seated tumors which invade other structures or exert pressure effects on neighboring organs may produce rather extensive symptoms from these effects. The anemia and loss of weight, which are usual with carcinoma, are absent in this disease.

Physical examination usually discloses a hard nodular circumscribed tumor of variable size. It is frequently fixed to the underlying structures and when removed may be larger than anticipated. In six of our cases the point of origin was in structures of the anterior abdominal wall, in five it was primary in the extremities, and in one, it was attached to the latissimus dorsi muscle.

Roentgen examination will frequently give useful information regarding these tumors, especially those situated in the extremities. The tumor may be seen as a circumscribed shadow of somewhat greater density than the surrounding soft tissues. It has the additional advantage of determining if there is any bone destruction or thinning of the cortex due to pressure atrophy. Periosteal thickening and irregularity of contour would suggest that the tumor was attached to the bone. In four of our cases these tumors could be visualized on the roentgen film. In one case local bone involvement was seen, and this was used as a guide in the future treatment of the case. In a second case bone changes secondary to radiotherapy could be differentiated from destruction of bone as seen in tumor destruction. In other cases bone destruction could be ruled out previous to operative procedures.

THERAPY

The problem of therapy in these cases is always a perplexing one due to the known tendency to local recurrence. In many instances a local excision is done under the

impression that the tumor is benign, and recurrence is consequently prompt. One is faced then with the question of wide excision—or amputation, if the origin is in one of the extremities. An alternative method of treatment to be considered is radiotherapy.

Meyerding, Broders, and Hargrave (2), in reporting the results of treatment in a series of these cases at the Mayo Clinic, state that the results of amputation in 34 cases, in which there were no demonstrable signs of metastasis, showed only 14.7 per cent five-year cures. Many of their cases had had previous operations. In a series of 21 patients, who had had only one previous excision, there were 14.3 per cent five-year cures. These writers believe that early amputation would probably cure a much larger percentage of the cases but would mean unnecessary sacrifice of the limbs in some cases. They state that among all of their cured cases there was a predominance of sarcomas of low grade malignancy. Among 28 cured cases, four had excision only, one had excision and Coley's toxins, 17 had excision and radiotherapy, and six had amputation.

Quick and Cutler (3), in a comprehensive study of 75 cases of various types, report 10 amputations in tumors of the extremities. Five patients were well, and five died of pulmonary metastasis soon after amputation. In 15 cases of tumor of the extremities treated by local excision and radiation therapy, eight patients died and seven were well for from two to nine years. These writers believe that the method of choice in the treatment of operable tumors, with the exception of the very malignant type, is pre-operative radiation therapy followed by wide surgical excision and immediate post-operative radiation therapy before the remaining tumor cells become incarcerated in the dense post-operative scar. It is generally accepted that the tumor bed is an important factor in prognosis, in cases submitted to radiation therapy, and that tumor cells embedded in fibrotic scar tissue do not respond in the same degree as they

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- (2) EAGLETON, W P Localized Bulbar Cisterna (Pontile) Meningitis Facial Pain and Sixth Nerve Paralysis and Their Relation to Caries of the Petrous Apex *Arch Surg*, March, 1930 **20**, 386-420
- (3) Idem Meningitis—The Result of Disease of the Petrous Apex and Sphenoidal Basis *Surg Gynec and Obst*, February (No 2A) 1935 **60**, 586-587
- (4) EBENIUS BERTIE The Results of Examination of the Petrous Bone in Auditory Nerve Tumors *Acta Radiol* 1934 **15**, 284-290
- (5) FREEDMAN, EUGENE Radiography of the Petrous Bone *Radiog and Clin Photog* March 1936 **12**, 10
- (6) FUCHS, A W Radiography of the Temporal Bone *Radiog and Clin Photog*, September, 1935 **11**, 2
- (7) GRADENIGO, G Über Circumscriphte Leptomeningitis mit Spinalen Symptomen und über Paralyse des N Abducens Otischen Ursprungs *Arch f Ohren-, Nasen-, u Kehlkopf*, 1904, **62**, 255
- (8) GEYMAN, MILTON J, and CLARK, DANIEL M The Roentgen Demonstration of Petrositis *Acta Radiol*, 1932, **13**, 125-133
- (9) GRANGER A Roentgen Examination of Paranasal Sinuses and Mastoids *Jour Am Med Assn*, Nov 1 1930, **95**, 1332-1335
- (10) JUNGERT, Y Einiges über das Syndroma Gradenigo und die Erfahrungen darüber an der Klinik auf Sabbatsberg *Acta Oto-laryng* 1931, **16**, 394-403
- (11) KOCH, C E Objective Otologic Roentgen Stereoscopy and its Significance for the Roentgen Diagnosis of Diseases of the Mastoid Process *RADIOLOGY*, July 1934 **23**, 75-79
- (12) KOPETZKY S J, and ALMOUR R Suppuration of the Petrous Pyramid, Pathology, Symptomatology, and Surgical Treatment (Parts 1 and 2) *Ann Otol Rhinol*, and *Laryngol* December, 1930 **39**, 996, and March 1931, **40**, 157
- (13) LAW, FREDERICK M Roentgen Examination of the Mastoid Processes *Am Jour Roentgenol and Rad Ther* April, 1934, **31**, 482-486
- (14) MAYER G *Otologische Röntgendeaquistik* Second ed, Julius Springer 1930
- (15) PANCOAST H K The Significance of Petrous Ridge Deformation in the Roentgen ray Diagnosis and Localization of Brain Tumors *Am Jour Roentgenol and Rad Ther* September 1928 **20**, 201-208
- (16) PERKINS C E Abducens Paralysis and Otitis Media Purulenta *Ann Otol Rhinol*, and *Laryngol*, 1910 **19**, 692
- (17) PROFANT H J Gradenigo's Syndrome with a Consideration of 'Petrositis' *Arch Otolaryngol* March 1931 **13**, 347-378
- (18) STENVERS H W Roentgenology of the Os Petrosum *Arch Radiol and Electrol* September 1917 **22**, 97
- (19) SUSSMAN M L Simple Technic for Roentgen Examination of Petrous Pyramid *Am Jour Roentgenol and Rad Ther* September, 1933 **30**, 415-418
- (20) TAYLOR H K The Roentgen Findings in Suppuration of the Petrous Apex *Ann Otol Rhinol*, and *Laryngol*, June 1931 **49**, 367-395
- (21) Idem Roentgen Findings in Suppuration of Petrous Apex (Petrositis) *Am Jour Roentgenol and Rad Ther* August, 1933 **30**, 156-162
- (22) Idem Suppuration in the Pneumatic Petrous Apex *Am Jour Roentgenol and Rad Ther* June, 1935 **33**, 767-773

last heard of, more than a year later. The last case was a recent one, and no conclusions can be drawn. The tumor was ex-

area, extending around to the scapula. It was quite hard, very tender to pressure, and about 6 cm in diameter.



Fig 1 Case 1

cised from the thigh by means of the cautery and was then given post-operative roentgen therapy. This was a cellular type of tumor and appeared more malignant from the histologic picture than many of the others.

CASE HISTORIES

Case 1. M. B., white female, 45 years of age. She came to the clinic in April, 1923, with the complaint of severe pain in the right shoulder, which had been developing gradually during the previous six months. At this time stiffness and impairment of function were present, also almost constant pain which interfered with sleep. A diagnosis of arthritis was made and physical therapy was advised. The patient was examined elsewhere, and a diagnosis of pressure symptoms from cervical ribs was arrived at. She was next seen in October, 1923. Examination disclosed evidence of a tumor mass in the axillary

X-ray examination of the shoulder revealed a soft tissue tumor along the axillary border of the scapula just below the glenoid. There was no bone destruction. There was atrophy of disuse of all the bones in this area (Fig 1).

At operation the tumor was found to be hard, fibrous, and encapsulated. It was adherent to the periosteum of the scapula and to the attachment of the latissimus dorsi muscle.

The pathological diagnosis was fibrosarcoma. It was thought to be a slowly growing, mildly malignant tumor of connective tissue origin.

Following the operation, one series of deep X-ray therapy was applied elsewhere—over the right axillary and scapular regions—a 110 per cent skin erythema dose being given.

The patient was seen again in June, 1924, at which time there was definite limitation of motion of the arm. X-ray ex-

cord Wassermann reactions were both negative. No family history of bone disorders could be elicited on either side.

The fractures are usually incident to some minor trauma and occur almost always in the diaphyses of the long bones or



Fig 1

Osteogenesis imperfecta tarda—Terms frequently used synonymously are *osteopetrosis* and *fragilitas ossium*. I believe the term *osteogenesis imperfecta tarda* is preferable since there appears to be very little difference between this condition and *osteogenesis imperfecta congenita* except that the manifestations are less severe and not present at birth. It was first described by Lobstein in 1833 and often is referred to as *Lobstein's disease*.

in the ribs. Cases have also been reported involving the fingers, mandible, patella, and pelvis. The femur is by far the most common site. Goin (3) reports that the average age at which the first fracture occurs is between the second and fourth year. The great majority occur between the ages of three and eleven, and they are uncommon after the age of twenty. The total number of fractures varies considerably although it is unusual to witness more than

last heard of, more than a year later. The last case was a recent one, and no conclusions can be drawn. The tumor was ex-

area, extending around to the scapula. It was quite hard, very tender to pressure, and about 6 cm. in diameter.



Fig 1 Case 1

cised from the thigh by means of the cautery and was then given post-operative roentgen therapy. This was a cellular type of tumor and appeared more malignant from the histologic picture than many of the others.

CASE HISTORIES

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Osteochondritis—Although this condition in its various manifestations is not generally regarded as congenital, there is no agreement as to the etiology and this assumption is permissible. Infection, endocrine disturbance, and trauma have been considered as basic factors, but there is little conclusive evidence to support these theories. Christie (1) notes that the locations in which the condition occurs are those which are subject to the slight but long-continued trauma of muscular pull, weight-bearing, and pressure, and states that this may interfere with the blood supply to the epiphysis during the period of rapid growth.

The most common site of involvement is the epiphysis of the head of the femur. This is the well-known *osteochondritis deformans juvenilis coræ* described by Calvé and Legg and Perthes in 1910. The epiphysis of the tibial tubercle is also rather commonly involved under the term *Osgood-Schlatter's disease*. Less frequently affected epiphyses are those of the tarsal scaphoid and the head of the second metatarsal, both of which conditions are usually referred to as *Köhler's disease*. The latter also may be called *Freiberg's disease* or *Freiberg's infarction*.

Osteochondritis deformans juvenilis dorsalis is an uncommon manifestation involving the vertebral epiphyses described by Scheuermann in 1921 and often called *Scheuermann's disease*. Various other epiphyses may become involved, such as those of the semilunar, os calcis and olecranon and the term *osteochondritis disseicans* is sometimes used in describing these conditions.

Congenital bone dysplasias which are characterized by hyperostotic changes comprise a small group of rare conditions. Hereditary and familial factors appear to be definitely present in the majority of cases reported.

Marble Bones—This uncommon disease was first described in 1904 by Albers-Schönberg with whose name it is usually associated. Other terms are *congenital osteosclerosis* and *osteopetrosis*. The changes

consist in an increase of hard cortical bone with partial or complete obliteration of the marrow cavity. The epiphyseal lines are still present but are irregular and the bones become hard and brittle, with resultant pathologic fractures. The condition is more or less generalized and occurs during the first age period. Karshner (8) believes a primary dyscrasia of the mesenchyme is responsible and the disease may begin *in utero*.

Meloreostosis—A localized form of hyperostosis was first described by Léri and Joanny, in 1922, under the name of *mélœreostosis*. The changes are confined to the bones of a single extremity and the involvement of the bones themselves is not generalized as in cases of marble bones. Léri described the radiographic appearance as that of wax along a candle and the term *flowing hyperostosis* is commonly used. In addition to the proliferation of cortical bone along the shafts of the long bones, irregular bony masses are deposited in the shoulder or hip which, as the condition progresses, may cause limitation of motion or fixation. Pathologic fractures have never been observed. The average age at which the first symptoms occur is 20 years. Kraft (10) states this may vary from five to 42 years, the progress being slow and the changes often remaining stationary for long periods.

Osteoporkilosis—This condition probably cannot be rightly classified as a hyperostotic involvement. The areas of increased density seen in the roentgenogram have been shown to be condensation of bone rather than proliferation, hence the term *disseminated condensing osteopathy*. The first case was described by Albers-Schönberg in 1915. Wilcox (15) found 17 reported cases through 1932 and added two more which occurred in father and son. His cases are the only ones showing blood relationship.

The roentgen changes consist of small areas of increased density in the spongiosa of the epiphyses and metaphyses and have been demonstrated in all the bones except those of the skull. The condition is symp-

back. This dosage was repeated weekly for four weeks, and after an interval of from four to six weeks the series was re-

area. There was also marked limitation of motion of the arm. In 1934 an ulcer formed over the point of the shoulder



Fig 4 Case 2

peated. This routine was continued during the following 18 months.

The palpable tumor mass regressed and disappeared in two months. In April, 1925, x-ray evidence of recurrence along the anterior border of the scapula was apparent. In July, 1925, there was evidence of involvement of a large part of the body of the scapula, with fracture through the neck of the scapula (Fig 2). Under continued x-ray therapy this remained stationary from that time. There was a moderate degree of pneumonitis along the axillary border of the lung, but this later disappeared.

After several years there developed a marked atrophy of the muscles of the shoulder and upper arm, with considerable telangiectasis of the skin over the treated

which resisted efforts to heal it (Fig 3). In July, 1934, gangrene of the arm developed due to thrombosis of the brachial artery, and the patient died following amputation of the arm. No autopsy was permitted.

Case 2. E. C., white male, 8 years of age. First seen in the clinic in September, 1930. At that time a history was obtained indicating that a tumor had been removed from the inner side of the left knee in another hospital during January, 1929. This recurred and had been again removed two weeks previous to the present admission. The tumor involved the soft tissues and apparently had no connection with the bone. The pathological diagnosis on each occasion had been fibrosarcoma.

THE RELATION OF ROENTGEN THERAPY TO THE TREATMENT OF FIBROSARCOMA

By HOWARD P DOUB, M D , *Detroit, Michigan*

From the Department of Roentgenology, Henry Ford Hospital

It is generally stated in medical literature that fibrosarcoma is markedly radioresistant, and therefore recurrence or metastasis would indicate a hopeless prognosis. Consequently, it has seemed wise to study the cases of fibrosarcoma which have been referred to us for radiotherapy, either because of recurrence after operation or as a prophylactic measure following operative removal of the tumor. We have selected all of the cases of fibrosarcoma which have had radiotherapy, and have not included the cases which have had surgery only.

The cases under consideration comprise only those of connective tissue origin. The benign fibromas and the more anaplastic types of sarcoma have been eliminated.

These tumors are commonly found in the skin and subcutaneous tissues, but in our series the point of origin was more commonly situated in the muscle sheaths or septa. Sex is not a differential point in the diagnosis as the distribution is fairly even. Such tumors may be found at any age, but in large reported series the preponderance of cases will be found in groups from the third to the seventh decades of life. They are somewhat more common in the third and fourth decades than is carcinoma. Antecedent trauma is not prominent in the history of these cases. French (1) reports that in only one case in his series of 16 cases was the cause of the tumor attributed to trauma. Stout (6) states that fibrosarcomas are sometimes found in cicatrices and that he has observed it personally in four cases. He also quotes from the literature cases in which these tumors have developed in areas subjected to prolonged irradiation. He believes, however, that these are of exceptionally rare occurrence.

The microscopic picture of these tumors is essentially fibromatous in character but has certain changes which characterize them as being malignant in nature. They are composed of interlacing strands of spindle cells and collagen fibers in varying amounts. There may be considerable variation in the size of the cells, and giant cells with multiple nuclei may be present. In general the malignant nature is shown by evidence of invasion, active mitosis, and anaplasia. Warren and Sommer (7) believe that "the most useful histologic criterion in determining a high degree of malignancy has been the presence of a fair to a marked number of giant cells." Mitotic figures are usually present in varying numbers, and if quite numerous usually indicate a malignancy of considerable activity.

French (1) states that when the nuclear material increases in proportion to the cytoplasm of the cells there is an increase in the mitosis and malignancy. He classifies these tumors in three groups according to the degree of malignancy. (1) Tumors of first degree malignancy were composed of spindle cells with a predominance of dense fibrous material and few cells. (2) In those of second degree malignancy there was less of the intercellular fibrosis. Large spindle cells in compact bundles were more prominent. (3) Tumors classified as third degree malignancy had little stroma, were highly cellular, and were made up of embryonic fibroblasts. In his cases the prognosis followed closely the histologic picture. The highly malignant forms recurred rapidly and the survival of the patient was short.

The symptoms produced by these tumors are usually slight. In most instances the patient is aware of a tumor mass for some months before increase in size and

formed slowly at the site of fracture, but on Feb 21, 1935, there was clinical evidence of union, and x-ray films showed a moderate amount of callus formation. The lungs were clear on May 1, 1935. Dur-

with other similar studies one may obtain certain impressions which in themselves are of considerable value.

We have not attempted to go into the minute classification of tumors which

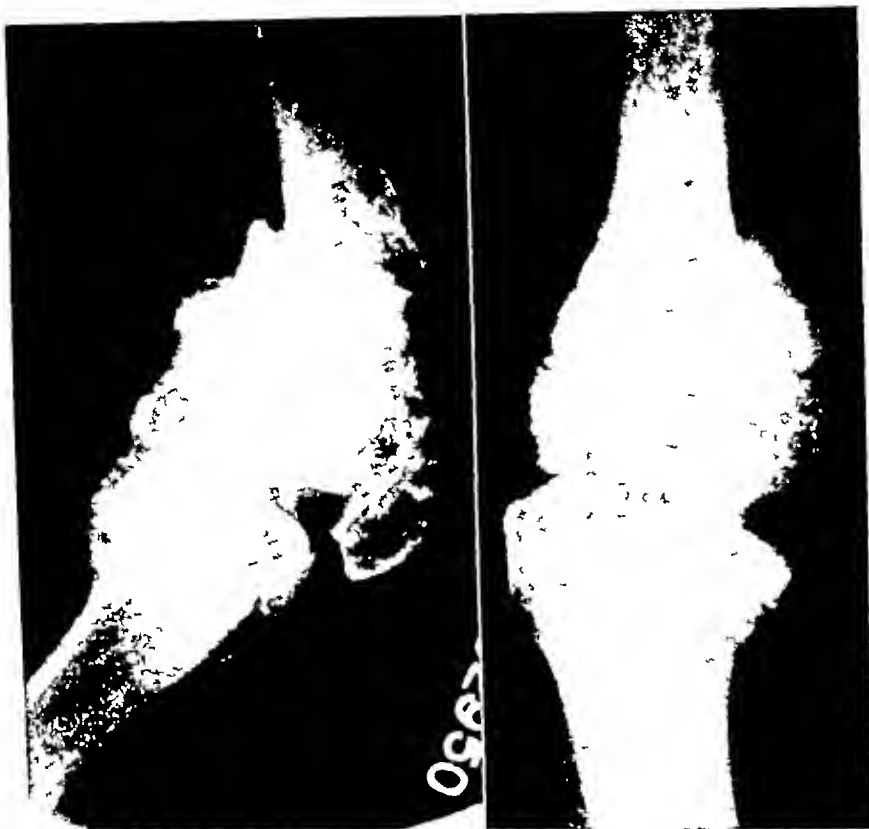


Fig 6 Case 2

ing all this time constant effort was made to secure permission for amputation, but the family refused each time.

During May the knee became swollen and gave every indication of recurrence of the malignancy. Biopsy confirmed the diagnosis.

X-ray films of the chest July 12, 1935, showed evidence of multiple areas of metastatic malignancy in both lungs. The patient expired Aug 16, 1935.

DISCUSSION

It is difficult to arrive at definite conclusions from the study of a small series such as this, but when taken in conjunction

might be included under this nomenclature. Certain authors believe that neurosarcomas constitute the majority of these tumors. There are other less well differentiated tumors which can be classified under the more inclusive term—fibrosarcoma. These are inclined to be less malignant and to metastasize less rapidly. When these tumors metastasize they do so through the blood stream and the metastases are usually found in the lungs. One of our patients died of metastases to the lungs, one developed metastases in the spine, and one had multiple tumors over the body. Of the cases in the series of Quick and Cutler (3), 20 per cent metastasized to the lungs.

do when the capillaries and fibroblasts are abundant

Warren and Sommer (7) reported a study of 163 cases of fibrosarcoma of the soft parts. Most of their cases were treated surgically. They found recurrence in 64 cases, and of these only eight patients were alive three years after treatment of their last recurrence. They state that recurrence is rare after the first year. A few of their cases received post-operative radiotherapy without any beneficial result, and several recurrent cases progressed in spite of active radiation therapy. They report five cases in which the tumor was associated with irritative stimuli of various kinds, and in two of these cases the growth developed in scars resulting from radiation therapy administered many years before.

French (1) studied a series of 16 cases which had had surgical treatment. One patient was well six years after operation, another three years, and another one year. Three other cases were too recent for him to estimate the results. He believes that the prognosis can be predicted from the laboratory analysis.

Stewart and Copeland (5), in presenting a group of neurosarcomas, state that most fibrosarcomas can be placed under that heading. They feel that it is difficult to conclude what is the best form of treatment for these tumors. They were uniformly disappointed by the results of interstitial irradiation by buried radon implants. Certain tumors of low grade malignancy did well from the use of external irradiation above. In tumors of high grade malignancy, however, this type of therapy was very disappointing. In their opinion the dosage of external irradiation must be pushed to the point of sloughing of the normal tissues, and small dosage is of no avail in this fatal disease.

All of our cases had surgical excision of the lesion followed by radiation therapy. Of the 12 cases which we wish to report, seven patients are well at the present time, three have died of metastases, and two others died without evidence of metastases as the cause of death. Recurrence after

operation developed in five cases—all are dead, but two did not die as a direct result of the tumor. In the seven cases in which recurrence did not develop, the patients are living and well at the present time.

One case (Case 1, below) had prompt recurrence, and under the influence of extensive roentgen therapy the tumor disappeared. There was marked muscular atrophy and skin changes as a result of the therapy. The patient died 11 years later from thrombosis of the brachial artery.

A second case, with a tumor primary in the lower leg, developed metastases in the spine, and radiotherapy was ineffectual, death following within a few months. A third case developed multiple metastases from a tumor of the thigh, one series of roentgen therapy was given post-operatively, but the patient died four years after operation. The fourth case (Case 2, below) developed local recurrence in the operative scar, and after extensive roentgen therapy developed pulmonary metastases and died five years after operation. The fifth case, a man aged 83 years, developed local recurrence in the forearm post-operatively. He had three series of roentgen therapy, but died three years later of general debility. There was still thickening present at the operative site.

Four cases were primary in the abdominal wall. These were all excised and post-operative roentgen therapy was applied. None of these patients developed any recurrence, and all are well at the present time. The time interval since the operation on these cases is eleven, eight, five, and five years, respectively. One other case was primary in the anterior chest wall. This was surgically excised and had post-operative roentgen therapy applied to it. This patient is living and well, with no recurrence, one year after operation.

Two cases originated in the extremities. One was primary in the heel and had metastatic glands in the groin. The primary tumor and the metastatic glands were excised and post-operative roentgen therapy was applied. The patient was well when

ally radioresistant and can be destroyed in many instances by extensive radiotherapy but, in so doing, considerable damage may be inflicted on the normal surrounding structures

5 Twelve cases are presented, in all of which surgical excision was followed by roentgen therapy. Seven of these patients are living and well at the present time, three have died of metastases, and two others have died without evidence of malignancy as the cause of death.

6 Two case histories are presented. One patient lived 11 years after recurrence in the scapula, which recurrence was treated by roentgen therapy, with resulting extensive muscular atrophy and telangiectasia. Death occurred after amputation of the arm because of thrombosis of the brachial artery. The other patient had recurrence in the region of the knee and was treated by means of roentgen therapy. Death occurred five years later from pulmonary metastases. Interference in bone growth and bone dissolution

occurred in the region of the epiphysis in this child.

7 Surgery, followed by adequate roentgen therapy, is advised, after warning the patient of possible damage to the normal structures.

BIBLIOGRAPHY

- (1) FRENCH, R. W. End results in a Series of Sixteen Cases of Fibrosarcoma. *New Eng Jour Med*, Feb 25, 1932, 206, 393-395.
- (2) MEYERDING, H. W. BRODERS, A. C. and HAR- GRAVE, R. L. Clinical Aspect of Fibrosarcoma of the Soft Tissues of the Extremities. *Surg, Gynec and Obst* June, 1936 62, 1010-1019.
- (3) QUICK, DOUGLAS, and CUTLER, MAX. Neuro- genic Sarcoma. *Ann Surg*, December 1927, 86, 810.
- (4) STEVENS, ROLLIN H. Retardation of Bone Growth Following Roentgen Irradiation of an Extensive Nevo-carcinoma of the Skin in an Infant Four Months of Age. *RADIOLOGY* November, 1935, 25, 538-544.
- (5) STEWART, FRED W. and COPELAND, MURRAY M. Neurogenic Sarcoma. *Am Jour Cancer*, July, 1931 15, 1235-1320.
- (6) STOUT, A. P. *Human Cancer*. Lea & Febiger, Philadelphia 1932.
- (7) WARREN, SHIELDS and SOMMER, GEORGE. Fibrosarcoma of the Soft Parts with Special Reference to Recurrence and Metastasis. *Arch Surg*, September 1936 33, 425-450.

amination showed an area of roughening along the axillary border of the scapula, suggesting the possibility of recurrence

After consultation with Dr P M Hickey it was decided that inasmuch as this was a radioresistant, slow growing type of tumor



Fig 2 Case 1



Fig 3 Case 1

She was next seen in September, 1924 when a hard mass was felt along the anterior border of the scapula and another mass above the scapula

X-ray therapy was started at that time

multiple small doses of x-ray therapy should be tried Accordingly, the following factors were used 190 kv 50 cm FSD, 0.5 mm Cu + 10 mm aluminum filtration, approximately 275 r units front and

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Examination at that time revealed a moderately advanced flexion contracture and some thickening about the scar area. No other findings of interest were found.

X-ray therapy was administered as

no involvement of the bones of the knee by the tumor (Fig 4).

X-ray examination of the knee on Dec 15, 1932 (Fig 5), showed evidence of eburnation around the epiphyseal lines and an

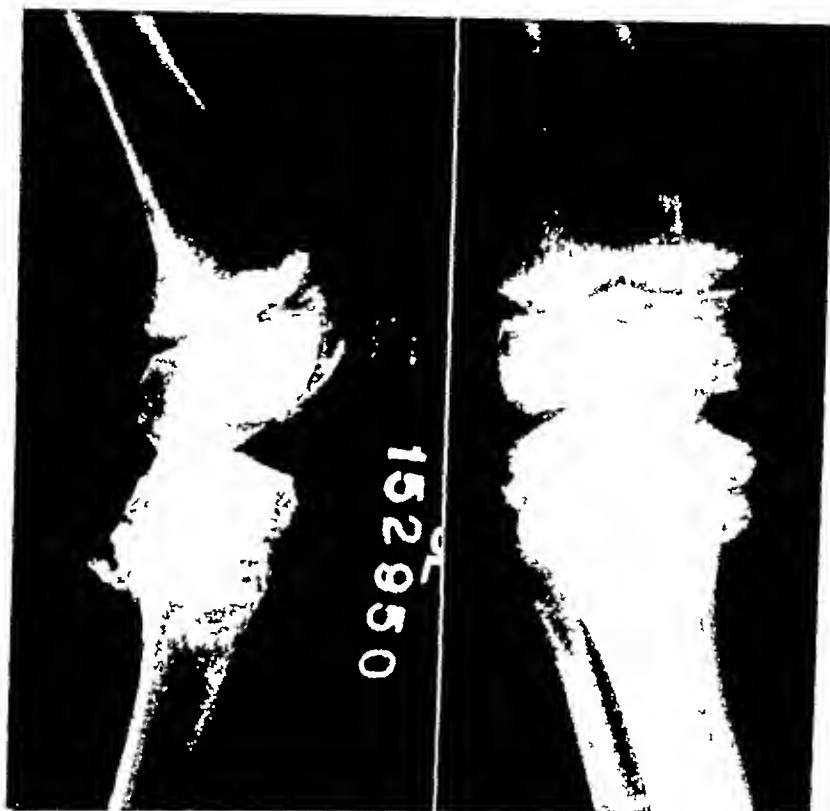


Fig 5 Case 2

follows: Oct 27, 1930, two portals (medial and lateral), 190 kv, 50 cm FSD, 0.5 mm copper and 1.0 mm aluminum filtration, 550 r units. Similar doses were applied Dec 30, 1930, March 14, 1931, May 26, 1931, Aug 10, 1931, and Oct 24, 1931. Post-operative X-ray therapy had also been applied before he was seen by us. The details are not available.

There was a gradual accumulation of fibrosis over the tumor area, but no definite tumor could be palpated. Some telangiectasis also developed in this area. The flexion contracture of the knee increased.

X-ray examination on admission showed

unusual type of bone production which was perpendicular to the cortex of the femoral epiphysis. There was also a beginning dissolution of the epiphysis of the tibia along its medial margin. This deformity increased slightly, and on Jan 6, 1934, the bone dissolution involved the medial portion of the diaphysis of the tibia just proximal to the epiphyseal line. The lungs were clear.

On Aug 16, 1934, the patient returned, stating that he fell while playing at school. X-ray examination revealed a fracture through the femur about two inches above the knee (Fig 6). The abnormal bone changes had progressed very little. Callus

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE EVOLUTION OF RADIOLOGY

A TRIBUTE TO DR. ROLLIN H. STEVENS, ONE OF AMERICA'S OUTSTANDING PIONEERS
IN THIS SCIENCE

It seems but yesterday that Rontgen's epochal discovery was flashed to the world and so, to those who were fortunate enough at that time to be on their way toward a medical career, congratulations are extended. And, when certain professional men have been still further favored by living through the intervening period and have been permitted to extend a guiding hand toward shaping the destinies of x-ray energy, that, too, may well be considered a fortuitous opportunity which is accorded to relatively few. One of those fortunate few is our own distinguished honoree, Dr. Rollin H. Stevens.

Let us look back for a moment to those stirring days in the late nineties when Rontgen's achievement startled the world. Let us recall to mind the press notices, the skepticism, the condemnation, the enthusiasm, the ridicule, the warnings, and in fact the entire potpourri of emotional misinformation which, sad to relate, still crops out from time to time despite over forty years of study and education through all the world's scientific channels of learning. Would that time permitted a review of all the points gained, all the suffering endured, all the difficulties overcome, all the disappointments, the hopes, the expenses, tersely, the total cost in human energy, endurance, and even death. And all this in order that the energy of radiation might be made useful and safe in the diagnosis, treatment, and cure of human disease. Now, at long last, the medical profession,

through its radiological members, has won the battle against ignorance and prejudice, and has placed the science of radiology upon its proper accredited plane.

Undoubtedly a number of Dr. Stevens' friends will contribute richly to our fund of scientific information in this splendid issue, so the writer will present only one controversial point—the problem of filtration. While still a medical student he had opportunity to come in contact with therapeutic radiation during its earliest experimental stages. Among those early memories is a distinct recollection of purchasing a can of white lead in oil and painting our tubes white with a small circular window opening directly over the anodal point of x-ray emergence. This was for "protection." Memory, however, is not very clear as to the early filters, although I seem to recall that filters of any kind were not used until 1897 or 1898. Anyway, it is certain that filtration was pure guess-work like every other factor involved in early radiation therapy, but as experience has accumulated I have become convinced that unfiltered or raw radiation has no place in modern medical practice. By radiation in this sense is meant x-rays and radium.

There are naturally those who take an opposite viewpoint. Nevertheless, when one meets, all too frequently, with numerous cases of superficial malignant disease conditions treated by fractional doses of semi-filtered or unfiltered x-rays or radium (and in the hands of competent men, too)

Examination at that time revealed a moderately advanced flexion contracture and some thickening about the scar area. No other findings of interest were found.

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no involvement of the bones of the knee by the tumor (Fig 4).

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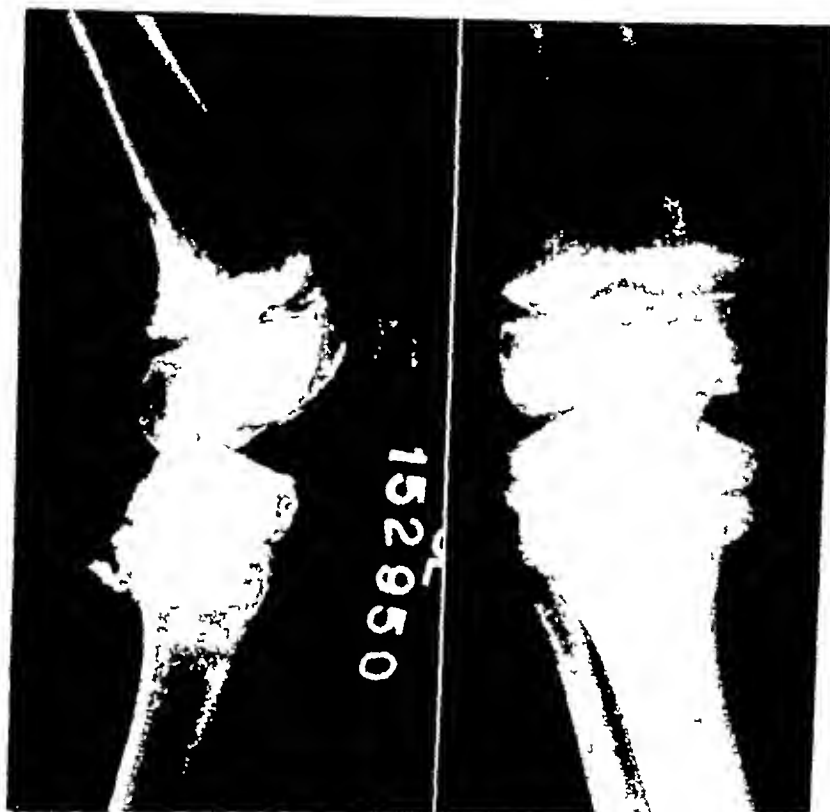


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On Aug 16, 1934, the patient returned, stating that he fell while playing at school. X-ray examination revealed a fracture through the femur about two inches above the knee (Fig 6). The abnormal bone changes had progressed very little. Callus

ray Company, passed away in Minneapolis, December 16, 1937. He had recently suffered from a rather severe sinus infection, and went to Florida to convalesce. Feeling that the completion of a new high voltage installation in Saint Paul demanded his attention, he made the trip, unwisely, as events proved. December 11 he was taken to the hospital with Type 3 lobar pneumonia, from which he succumbed.

Mr Werner has always been a close friend of this Society, and many radiologists will be saddened to hear of his passing. A close tie must of necessity exist between makers and users of roentgen apparatus, and Mr Werner was always counted one of us.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

LA HERNIE POSTERIEURE DU MENISQUE INTERVERTEBRAL (HERNIE NUCLEAIRE POSTERIEURE), ET SES COMPLICATIONS NERVEUSES. By PIERRE GLORIEUX. A volume of 102 pages, with 98 illustrations. Published by Masson et Cie, Paris, 1937. Price 40 fr.

PRIMARY CARCINOMA OF THE LUNG. By EDWIN J. SIMONS, M.D., with Foreword by J. ARTHUR MYERS, M.D., Professor of Medicine and Preventive Medicine and Public Health, University of Minnesota, President National Tuberculosis Association. A volume of 263 pages, with 30 illustrations. Published by Year Book Publishers, Chicago, 1937. Price \$5.00.

ATLAS OF SKELETAL MATURATION. By T. WINGATE TODD, M.B., Ch.B. (Manc.), F.R.C.S. (Eng.). A volume of 202 pages, with 35 illustrations. Published by the C.V. Mosby Company, St. Louis, 1937. Price \$7.50.

BOOK REVIEWS

ARTIFICIAL FEVER PRODUCED BY PHYSICAL MEANS: ITS DEVELOPMENT AND APPLICATION. By CLARENCE A. NEYMANN, A.B., B.S., F.R.S.M., Associate Professor Psychiatry, Northwestern University Medical School, Honorary Professor of Medicine, National University of Mexico, C.R.B., Exchange Professor of the University of Ghent, Liege,

Louvain, and Brussels, Belgium. A volume of 293 pages, with 68 illustrations and 4 colored plates. Published by Charles C. Thomas, Springfield, Illinois, 1937. Price \$6.00.

To my knowledge this is the first textbook on this subject. It contains fifteen chapters covering in order the history, physiology, technic, and application in various clinical conditions. The subject matter is clear and concise and gives an excellent description of the various methods of producing artificial fever. The various methods of producing artificial fever are described briefly and the apparatus for each method are shown clearly in several figures. The chapters on the clinical application of artificial fever recite the results obtained by many workers as well as those of the author. The book is particularly advantageous because of its extensive bibliography in which some 556 references are listed.

I believe this book will be of great value to anyone interested in the use of artificial fever since it is a good résumé of the work carried on in the production of fever by artificial means by the author and other outstanding workers in this field of medicine.

L'ARTERIOGRAPHIE DES MEMBRES ET DE L'AORTE ABDOMINALE: ÉTUDE CRITIQUE. By HENRY REBOUL. A volume of 136 pages, with 81 illustrations. Published by Masson et Cie, 1935. Price 40 fr.

This monograph is a fairly comprehensive and definitely enthusiastic treatise on the subject of arteriography and its possibilities. The author reviews the literature and discusses the various types of contrast media which have been used. His experience is based on 218 injections for arteriography, given to 140 patients. He devotes one chapter to accidents and untoward results. His technic is for the most part that of Dos Santos. He uses transcutaneous arterial puncture under general anesthesia and injects the medium under a mechanical pressure of from 1 to 1.5 kg. He abandoned thorotrast as a contrast medium chiefly because of its retention in the body and because of the question of its radio-activity. He used for the majority of his arteriograms a 45 per cent solution of "Tenebryl," sodium dnodomethane sulphonate, and gives reasons why he feels that this is superior to other iodides. The 81 illustrations are for the most part good arteriograms but their impressive-

The prognosis in these tumors is not good, although here as in all other malignant tumors the stage of the disease is an important factor in estimating the probable outcome. Most authors believe that the most reliable prognostic sign is the histologic picture and that cases showing a high grade malignancy have an extremely high rate of mortality. In a large series such as that reported by Meyerding, Broders, and Hargrave (2) the five-year survival was in the neighborhood of 14 per cent. Stout (6) believes that in the very malignant type the survival will be less than 10 per cent regardless of the type of treatment used. Four of our cases died within five years, and one after eleven years. In two of these the tumor was not the cause of death.

It is difficult to appraise accurately the value of post-operative radiation therapy at this time, but it is our opinion that in those series in which this treatment has been liberally used the results show an improvement over straight surgical treatment. It is universally agreed that fibrosarcoma is a radioresistant tumor, but one is also favored by the fact that in a large number of cases the tumor remains localized for a considerable period, thus allowing sufficient time for the application of extended radiotherapy. With the newer methods of radiotherapy a much larger amount of radiation can be applied than formerly, and thus the problem of radioresistance is not so formidable as it once was.

In operable cases we recommend wide surgical excision, preferably by means of cautery, followed by prompt and vigorous roentgen therapy. Because of the lack of radiosensitivity the normal tissues cannot be spared and severe reactions may occur. Extensive muscular atrophy and telangiectasis of the skin sometimes occur, especially in cases in which an inoperable recurrence develops. In Case 1, reported here, such a recurrence developed, and under the influence of long continued radiation therapy marked atrophy of the muscles resulted as well as extensive telangiectasia.

This soft tissue change was indirectly the cause of the patient's death 11 years later.

In cases in which the patient is in the growing age with unclosed epiphyseal lines radiation therapy of any severity will frequently cause retardation of growth or even cartilaginous and bone fragmentation. A case of retardation of bone growth following roentgen therapy was reported several years ago by the man we are delighted to honor, Dr. Rollin H. Stevens (4). In our Case 2 the bone and joint changes were very striking. There was extensive dissolution of the devitalized bone and eventually fracture occurred from relatively light trauma.

We are, therefore, confronted by the dilemma of a persistent, fatal type of tumor, which in most instances is quite resistant to radiation therapy, situated in areas in which the surrounding and underlying tissues should be preserved if possible, and the fact that if sufficient radiation is applied to the tumor to cause its destruction these normal tissues will in all probability be irreparably damaged. We believe that if the facts can be fairly presented to the patient, little difficulty will be encountered in carrying out the necessary therapy.

SUMMARY

1 We are considering here fibrosarcoma of connective tissue origin. It is often a lesion of benign appearance and its serious import may not be known until the most favorable time for treatment has passed.

2 These tumors are essentially fibromatous in character, but their malignant nature is usually shown by evidence of invasion, mitosis, and anaplasia. The histologic picture is an excellent guide to the prognosis.

3 They may cause few symptoms, and these due to pressure. Roentgen examination will sometimes give assistance in outlining the tumor and in determining secondary bone changes.

4 The treatment consists of surgery and radiotherapy. The tumors are usu-

evidence bearing on the mechanism involved in the action of roentgen rays and the gamma rays of radium on living tissue. The second portion is devoted to a report of experiments carried out by the author to elucidate obscure phases of the action of roentgen rays and radium on certain tissues, especially the muscular tissues of the heart which are known to be resistant to irradiation, and on the eggs of the Blue Bottle fly which are distinctly sensitive to irradiation. In the experiments on the Blue Bottle fly the author investigated the effect of varying the intensity of irradiation, the effect of the changes in the rate of development of the eggs during irradiation as affected by temperature, by injury, and by irradiation, separately or combined, the effect on radiosensitiveness of injury produced by asphyxia or injury produced by x-rays or both, the effect on radiosensitiveness of anesthesia such as chloroform, nitrous oxide, ether, and certain fat solvents such as petrol ether, by themselves or in combination with roentgen irradiation.

The first portion of this brief monograph in which the author discusses and analyzes the evidence bearing on the action of roentgen rays and the gamma rays of radium on living tissue is perhaps the best effort of the kind with which the reviewer is familiar. The author is to be highly complimented on his ability to set forth the experimental work which has already been done and to analyze it clearly and soundly. This monograph should be read by everyone who wishes to know and to understand as much as possible about the action of roentgen rays and the gamma rays of radium on living cells.

MORPHOLOGISCHEN UND TIEREXPERIMENTELLE STUDIEN ÜBER DAS SCHLEIMHAUTRELIEF DES MAGEN-DARMKANALS Beitrag zur Kenntnis der anatomischen Unterlage des Schleimhautreliefs und des Mechanismus der Faltenbildung. By STEN GRETTVE, M D. *Acta Radiologica, Supplementum XXXI*. Published by P. A. Norstedt & Son, Stockholm, 1936. A volume of 124 pages, with 43 illustrations. Price 10 Sw cr.

The author investigates in morphological and pharmacological studies, together with animal experiments, the mucosa relief of the gastro-intestinal tract and continues Forsell's work concerning the autoplasmic of the gastric mucosa. He concludes that the formation of folds is due to an active creative power of the muscularis mucosæ and muscularis propriæ, shaped ac-

cording to its need of digestion. These studies complete also O. Dye's and W. Knothe's pharmacological experiments in regard to mucosa changes in man and reflect Chaoul's doctrine of the preformation of the mucosal folds. As to the practical clinical side of the study, it constitutes an important contribution, especially for the evaluation of inflammatory changes of the gastro-intestinal mucosa.

THE COLLAPSE THERAPY OF PULMONARY TUBERCULOSIS By JOHN ALEXANDER, M D, F.A.C.S., Professor of Surgery, University of Michigan, Surgeon-in-Charge, Division of Thoracic Surgery, Department of Surgery, University of Michigan Hospital. A volume of 705 pages, with 367 illustrations. Published by Charles C. Thomas, Springfield, Illinois, 1937. Price \$15.00.

Twelve years ago, when "The Surgery of Pulmonary Tuberculosis" was published, treatment of tuberculosis consisted of a regimen in which general physical and pulmonary rest were obtained and continued over an indeterminate period of years. Sanatoriums were filled with patients who had advanced fibroid tuberculosis and who continued vain efforts to regain health and return to work. Surgical methods, with the exception of infrequent induction of collapse of the lung by pneumothorax, were looked on with suspicion. Alexander's fine work brought about gradually a complete reversal of practice. Other important works also contributed to that end, so that now many large sanatoriums find that 75 per cent of their patients are suitable for one or more types of surgical treatment.

In the present work, Alexander and his co-workers have enlarged the scope of the first book to such extent that they are able to assemble in one volume a discussion of all methods accepted as valuable in treatment of tuberculosis. Any student can find, either in the content of this work or in the works referred to in the bibliography, all that is at present known about treatment of the patient who has tuberculosis. Twelve years ago there were 500 references in the bibliography; now there are 1,342 articles and books whose authors express the views taught in all parts of the world. Of these, Alexander has contributed thirty-four of his personal publications. One cannot overestimate the importance of the chapter, containing thirty-eight pages, that deals with the

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

CALENDAR

Meetings Falling Between the Dates of January 15 and February 28

January 28, 29 Annual meeting of Conference of Eastern Radiologists, at the Warwick Hotel 1701 Locust St., Philadelphia

February 11, 12 Second annual conference of Mid west Radiologists Muchlebach Hotel, in Kansas City Mo

Editor's Note—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section

CALIFORNIA

California Medical Association, Section on Radiology—Chairman, John D. Lawson, M.D., 1308 California State Bldg, Sacramento, Secretary Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles Meets annually with California Medical Association

Los Angeles County Medical Association Radiological Section—President John F. Chapman M.D., 65 N. Madison Ave., Pasadena Vice president E. N. Liljedahl M.D., 1241 Shatto St. Secretary Merl L. Pindell M.D., 678 South Ferris Ave. Treasurer Henry Snure M.D., 1414 Hope Street Meets every second Wednesday of month at County Society Building

Pacific Roentgen Club—Chairman, Raymond G. Taylor M.D., 1212 Shatto St., Los Angeles, Secretary, L. Henry Garland M.D., 450 Sutter St. San Francisco

COLORADO

Denver Radiological Club—President John S. Bouslog M.D., 246 Metropolitan Bldg., Vice president Sanford Withers M.D., 304 Republic Bldg., Secretary, Ernst A. Schmidt M.D. Colorado General Hospital Treasurer H. P. Brandenburg M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members

CONNECTICUT

Connecticut State Medical Society Section on Radiology—Chairman Kenneth K. Kinney M.D., 29 North Street, Willimantic, Vice-chairman Francis M. Dunn M.D., 100 State Street, New London Secretary-Treasurer, Max Cluman, M.D., 242 Trumbull St. Hartford Meetings twice annually in May and September

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society

FLORIDA

Florida State Radiological Society—President, Gerald Raap M.D., 168 S. E. First St. Miami Vice presi-

dent, H. O. Brown, M.D., 404 First Nat'l Bank Bldg., Tampa, Secretary-Treasurer H. B. McEuen, M.D., 126 W. Adams St., Jacksonville

GEORGIA

Georgia Radiological Society—President James J. Clark, M.D., Doctors Bldg. Atlanta, Vice president William F. Lake, M.D. Medical Arts Bldg. Atlanta, Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic, Americus Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring

ILLINOIS

Chicago Roentgen Society—President, David S. Bedin, M.D., 411 Garfield Ave., Vice president Chester J. Challenger, M.D., 3117 Logan Blvd., Secretary-Treasurer, Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May except December

Illinois Radiological Society—President Ivan Brouse M.D., 316 W. State, Jacksonville, Vice president, Cesar Gianturco, M.D., Carle Hospital Clinic Urbana, Secretary-Treasurer, Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur Meetings quarterly by announcement

Illinois State Medical Society, Section of Radiology—President, Roswell T. Pettit M.D., 728 Columbus St. Ottawa, Secretary, Ralph G. Willy M.D., 1138 N. Leavitt St. Chicago

INDIANA

Indiana Roentgen Society—President J. N. Collins, M.D., 23 E. Ohio St. Indianapolis President-elect Stanley Clark, M.D., 108 N. Main St., South Bend Vice president Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne, Secretary-Treasurer Clifford C. Taylor M.D., 23 E. Ohio St. Indianapolis Annual meeting in May

IOWA

The Iowa X-ray Club—Holds luncheon and business meeting during annual session of Iowa State Medical Society

MAINE

See New England Roentgen Ray Society

MARYLAND

Baltimore City Medical Society, Radiological Section—Chairman, Marcus Ostro M.D., 1810 Eutaw Place, Secretary H. E. Wright, M.D., 101 W. Read St. Baltimore Meetings second Tuesday of each month

MASSACHUSETTS

See New England Roentgen Ray Society

MICHIGAN

Detroit X-ray and Radium Society—President C. C. Birkelo M.D. Herman Keifer Hospital Vice presi-

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Animal Experimentation	142	Cancer (Therapy)	144
Arteriography	142	Diathermy	144
Biologic Experimentation	142	Dosage	144
The Blood	142	The Ear (Middle)	144
Bone Diseases (Diagnosis)	142	Encephalography	145
Bone Diseases (Therapy)	143	The Esophagus	145
Bones Tumors	143	Gall Bladder (Normal and Pathologic)	145
The Brain	143	Gastro-intestinal Tract (Diagnosis)	145
Breast Cancer	144	Genito urinary Tract (Diagnosis)	146
Cancer (Diagnosis)	144	Genito urinary Tract (Therapy)	146

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S M ATKINS M D of Waterbury Conn	LEWIS G JACOBS M D, of Madison Wis
S RICHARD BEATTY, M D of Madison Wis	ERNST A POHLE M D, Ph D, of Madison Wis
G E BURCH M D, of New Orleans La	W A SODEMAN M D of New Orleans La
J E HABBE M D of Milwaukee Wis	

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

BADE H, and BADEN K The Post-operative Irradiation of Cancer of the Breast	144	HAMANN, A <i>with</i> HOLTHUSEN, H jt auth	144
BADEN K, <i>with</i> BADE H jt auth	144	HANSSON C J Chronic, Non-specific Regional Ileocolitis	145
BENDER MORRIS B, <i>with</i> SAVITSKY, NATHAN, jt auth	145	HARDMAN T GARRATT Cholecystography The Efficiency of the Graham-Cole Test	145
BERNASCONI M Congenital Abnormalities in the Urinary Tract of a Six year-old Child	146	HOLTHUSEN H, and HAMANN A The Co-operation of the Hospital in the Fight against Cancer	144
BERTINI M <i>with</i> CAFFARATTO T M jt auth	146	KELBLING W <i>with</i> KIRCHHOFF H, jt auth	142
BERTREAU, <i>with</i> SERRAND jt auth	143	KIRCHHOFF H and KELBLING W Experimental Contribution to the Problem of the Time Factor	142
BRENNEKE H Radiation Injury of the Sperma of Mice and Rats as Observed on the Early Development of the Ova	142	KIRKLIN B R <i>with</i> GOOD C ALLEN, JR	145
BUSH G <i>with</i> GAGE C jt auth	146	MACMILLAN, A S Cholesteatoma in Chronic Otitis Media	144
CAFFARATTO T M and BERTINI, M Effect of Various Wave Lengths on the Aschheim Zondek-Friedmann Reactions	146	OESER, H <i>with</i> CHAOL H jt auth	144
CHAOL, H, GREINER K and OESER H The Results of Several Years Roentgen Therapy with Small Focal Skin Distance in Carcinoma of the Skin and Lip	144	PATERSON, R S, <i>with</i> GAGE C jt auth	146
DEMEI R and SGALITZER M Diagnostic and Therapeutic Relation of Arteriography	142	POULSSON KARE T Non specific Osteitis of the Ribs	142
ETTORRE E Osseous Echinococcosis	143	PROUZET J and REBEROL Osteochondromatosis of the Tibio tarsal Articulation	143
FELLER A The Effect of Radium and of Benzol on the Blood and Blood forming Organs, with Special Consideration of the Leucocytes	142	REBEROL, <i>with</i> PROUZET J jt auth	143
FRIED C <i>with</i> GUTTMANN L jt auth	143	SAVITSKY, NATHAN and BENDER, MORRIS B Tumor of the with Brain Normal Encephalogram	145
GAGE C SHANKS S C PATERSON R S and BUSH, G Discussion on Some of the Less Common Lesions and Special Methods of Investigation of the Alimentary Tract and the Influence of Adjacent Organs	146	SERRAND and BERTREAU A Case of Bilateral Articular Chondromatosis	143
GLAUNER, R Roentgen Therapy of Hand-Schüller Christian's Disease	143	SGALITZER M, <i>with</i> DEMEI R jt auth	142
GOOD C ALLEN JR and KIRKLIN B R The Influence of Extra biliary Disease on the Function of the Gall Bladder A Cholecystographic Study	145	SHANKS S C <i>with</i> GAGE C jt auth	146
GREGORI A The Biologic Effect of Continuous and Periodically Interrupted Roentgen Irradiation upon the Eggs of the Fruit Fly	142	SOULAS A Narrowing of the Inferior Esophagus as a Clinical Entity	145
GREINER K <i>with</i> CHAOL H, jt auth	144	TILLEY HERBERT Cancer of the Esophagus Treated by Deep X ray Therapy	145
GUTTMANN L and FRIED C Problem of Post-operative Irradiation in Brain Tumors	143	UMBER FRIEDRICH Diverticula of the Digestive Tract	146
		WERNER R The Problem of Cancer Families	144
		WITTE E The Qualitative and Quantitative Differences in the Radiation Emitted between Natural Sun and Therapeutic Lamps Description of a New Lamp Emitting Practically the Same Spectrum as the Sun	144
		ZACHARIAS P Influence on the Biologic Object of Rhythmic Interruption of Roentgen Irradiation	144

beth's Hospital, Youngstown, *Secretary-Treasurer*, Harry Hauser, M D, Cleveland City Hospital, Cleveland Meetings at 8 30 P M at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists)—*President*, George Benzing, M D, St Elizabeth Hospital, Covington, Ky, *Secretary-Treasurer*, Justin E McCarthy, M D, 707 Race St, Cincinnati Ohio Meetings held third Tuesday of each month

PENNSYLVANIA

Pennsylvania Radiological Society—*President*, Sydney J Hawley, M D, Geisinger Memorial Hospital Danville, *First Vice president*, William J McGregor, M D, 744 Franklin Ave, Wilkesburg, *Second Vice-president*, Oscar M Weaver, M D, 12 S Main St Lewistown, *Secretary Treasurer*, Lloyd E Wurster M D, 410 Pine St, Williamsport, *President-elect*, Charles S Caldwell, M D, 520 S Aiken Ave, Pittsburgh Annual meeting, May, 1938 Exact date and place to be decided

Philadelphia Roentgen Ray Society—*President*, Thomas P Laughery, M D, Germantown Hospital, *Vice president* Elwood E Downs, M D, Jeans Hospital Fox Chase, *Secretary*, Barton H Young, M D Temple University Hospital, *Treasurer*, R Manges Smith M D, Jefferson Hospital Meetings first Thursday of each month from October to May, Thompson Hall College of Physicians, 19 S 22nd St, 8 15 P M

The Pittsburgh Roentgen Society—*President*, F L Schumacher, M D, Jenkins Arcade, *Secretary*, H N Mawhunny, M D, Mercy Hospital Two Fall and two Spring meetings at time and place designated by president

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

South Carolina X ray Society—*President*, Robert B Taft, M D, 105 Rutledge Ave, Charleston, *Secretary-Treasurer* Hilyer Rudisill, M D, Roper Hospital, Charleston Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association

SOUTH DAKOTA

Meets with Minnesota Radiological Society

TENNESSEE

Memphis Roentgen Club—*Chairmanship* rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

Tennessee State Radiological Society—*President*, H S Shoulders, M D, 246 Doctors Bldg, Nashville, *Vice president* S S Marchbanks, M D, 508 Medical Arts Bldg, Chattanooga, *Secretary Treasurer*, Franklin B Bogart, M D, 311 Medical Arts Bldg, Chattanooga Meeting annually with State Medical Society in April

VERMONT

See New England Roentgen Ray Society

VIRGINIA

Radiological Society of Virginia—*President*, Fred M Hodges M D, 100 W Franklin St, Richmond *Vice president*, L F Magruder M D, Raleigh and College Aves, Norfolk, *Secretary*, V W Archer M D University of Virginia Hospital, Charlottesville

WASHINGTON

Washington State Radiological Society—*President*, H E Nichols, M D, Stimson Bldg, Seattle, *Secretary*, T T Dawson, M D, Fourth and Pike Bldg, Seattle Meetings fourth Monday of each month at College Club

WISCONSIN

Milwaukee Roentgen Ray Society—*Secretary* S A Morton, M D, Columbia Hospital, Milwaukee Meets monthly on first Friday

Radiological Section of the Wisconsin State Medical Society—*Secretary*, Russel F Wilson, M D, Beloit Municipal Hospital, Beloit Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September

University of Wisconsin Radiological Conference—*Secretary*, E A Pohle, M D, 1300 University Ave, Madison, Wis Meets every Thursday from 4 to 5 P M, Room 301, Service Memorial Institute

NEWS ITEM

The Georgia Radiological Society was organized at the Palmer House Chicago, during the Fifth International Congress of Radiology The first regular meeting was held in Atlanta Ga Nov 27 at the Academy of Medicine The program consisted of a round table discussion of difficult diagnostic cases and of therapy problems Fifteen men were present A constitution and by-laws were adopted and plans made for the next meeting in conjunction with the Medical Association of Georgia at Augusta next spring The meeting was followed by a luncheon at the Biltmore Hotel

two tuberculous osteitis of the ribs is by far more common, the syphilitic type being seldom encountered. Acute specific infectious osteitis of the ribs is seen in typhus and febris undularis. Non-specific, metastatic osteitis of the ribs is regarded as a very rare affliction, accounting for 0.8 to 2 per cent of all cases of osteomyelitis recorded. Non-specific osteitis of the ribs occurs in young individuals. There is probably a six-month interval between the appearance of the primary infection and metastasis to the ribs. In individuals in the growing period the disease is almost always acute with definite local as well as general symptoms and a tendency to rapid destruction with suppuration and formation of fistulae. In individuals over 25 years of age, the clinical picture is quite different, the symptoms develop slowly and the condition runs a chronic course. Local and constitutional symptoms are mild. Occasionally there are no symptoms and the osteitis of the rib is accidentally discovered. These findings are said to be due to the poor vascularization of the ribs after the age of 25 years. *Staphylococcus aureus* and *albus* and less frequently, the *Streptococcus* and the *Pneumococcus* were found to be the offending organisms. Expectant treatment seems to be indicated at first especially if one bears in mind those cases in which operation has led to a lesion of the pleura and empyema. The prognosis is favorable except when it is associated with a generalized septicemia. Poulsion reports three cases of non-specific osteitis with a number of roentgenograms illustrating the roentgenographic picture of the disease.

G E BURCH M D

BONE DISEASES (THERAPY)

Roentgen Therapy of Hand-Schuller-Christian's Disease. R. Glauner. *Strahlentherapie* 1937 60, 58.

The author reports a case of Hand-Schuller-Christian's disease with involvement of the skull and upper left femur. There was also destruction of the sella turcica, with exophthalmos. Roentgen therapy was given to the skull through three areas: 180 r, 120 r and 180 r were applied over these areas so that during a three-week period the total surface dose amounted to 1,020 r. A total surface dose of 1,080 r through two areas was given to the upper left femur. During that time a new lesion appeared in the right upper tibia. This received a total surface dose of 720 r. The bone lesions improved after the treatment as well as the exophthalmos. Further treatment was given one month later. Six months after the last series there was complete healing of all bone lesions. The child had developed normally and no new lesions had appeared. The author points out that apparently high doses are required in his case for instance 2,100 r to the skull and 2,280 r to the upper thigh. The response of this disease to roentgen rays can well be explained by the histological character of the lipoid granulomatous tissue.

ERNST A. POHLE M D Ph D

Osseous Echinococcosis. E. Ettorre. *Arch ital di chir* January, 1937, 45, 149-174. (Reprinted by permission from *British Med Jour*, May 22 1937, p. 81 of *Epitome of Current Medical Literature*.)

The author, who records a personal case of echinococcus disease of the scapula, states that localization of the disease in bone is rare, as Ivanissevitch, among 1,734 cases of echinococcus disease notified in the Argentine Republic found only 29 cases (1.6 per cent) in which a bone was involved. Ettorre could collect only eight cases beside his own in which the scapula was affected. His patient was a woman aged 28, a native of Milan, who at the age of 12 had received a violent blow on her left shoulder. About three years later she began to feel pain in the shoulder which was attributed to pleurisy and treated as such. During the last three years pain was felt in movements of the shoulder especially on abduction and internal rotation, and a diagnosis of arthritis was made. Shortly afterwards a swelling appeared, gradually increasing in size. As the result of radiological examination and exploratory puncture a diagnosis of echinococcus disease of the scapula was made and the cysts successfully removed. Complete recovery took place.

BONES, TUMORS

Osteochondromatosis of the Tibio-tarsal Articulation. J. Prouzet and Reberol. *Bull et Mém Soc Radiol Méd de France*, January 1937 25, 93-94.

Osteochondromatosis of the ankle joint is a rare condition. The authors find but three recorded cases. Their case, a man 25 years of age had sprained his ankle six years previously. This was treated by rest and massage. Subsequently massage relieved him of an occasional recurrence of swelling and pain. The x-ray showed a mass of small calcified bodies of indefinite outline anterior and posterior to an otherwise quite normal ankle joint. A second film, six months later showed decrease in number of the smaller osteophytes.

S. RICHARD BEATTY, M D

A Case of Bilateral Articular Chondromatosis. Serand and Bertreaux. *Bull et Mém Soc Radiol Méd de France* February, 1937 25, 114, 115.

A case of bilateral chondromatosis of the elbows is presented, interesting also in that there were deformities of the radius and ulna due to osteophytes in the region of the articular margins.

S. RICHARD BEATTY, M D

THE BRAIN

Problem of Post-operative Irradiation in Brain Tumors (Clinical Part, L. Guttman. *Strahlentherapie* 1937 59, 316. Roentgen Part, C. Fried, *ibid* p. 328).

The first paper deals with the clinical and surgical aspect of brain tumors while the second paper contains the report of the roentgenologist. The author uses 180 kv, 4 ma, 0.5 mm Cu + 1 mm Al, 40 cm F.S.D.,

and finds, as a result, that further radiation treatment is futile, the general subject of filtration offers a broad field for discussion. There may be good reasons, theoretical or otherwise, for the use of unfiltered radiation but when such treatment is given in connection with neoplastic disease affecting not only the skin but all structures immediately underneath, there seems to be no plausible reason for its use. Therefore, based upon my own experience in the use of both x-rays and radium up to their new high levels of short wave output, I desire to go on record as voicing my unqualified opposition to the use of unfiltered x-rays or radium containers for any human ailment or for the treatment of any disease. This statement is not given by virtue of any enthusiastic impulse but is based solely upon our daily experience and observation during a lifetime service with radiation therapy.

Whether this expression of opinion finds favor in the eyes of our honored friend Rollin Stevens, I do not know. I do know, however, that the energy of radiation will remain young over many centuries to come, like our own Dr Stevens, who has remained young and virile and will continue to do so to the end.

Dr Stevens has contributed much of his own forceful and pleasing personality to each and every phase of radiological progress, he has lent a guiding hand in correcting abuses in radiation therapy, he has become an authority on therapeutic radiology, and particularly that branch dealing with skin and superficial disease, he has been instrumental in placing this important branch of medical practice upon the highest professional plane—Dr Stevens, whose virile manhood and staunch Americanism have been an inspiration to all who have been fortunate enough to know him as a teacher and a man. To you, Dr Stevens, may I be permitted to inscribe these lines in grateful memory of many profitable and delightful hours spent in your congenial company. Rollin, time has been kind to you. It has permitted you to reach the honorable age of three score and ten in full

possession of your mental and physical vigor. May you continue on in the pursuit of your work and play, and may you find at every port of call a snug harbor and a cozy berth. God bless you!

ALBERT SOILAND, M D

ANNOUNCEMENTS

FURTHER HONORS FOR A MEMBER OF THE SOCIETY

Dr Francis Carter Wood, Director of the Institute of Cancer Research, Columbia University, and Editor of the "Journal of Cancer," has been decorated with Belgium's Order of the Crown. King Leopold III conferred the honor upon Dr Wood in recognition of the latter's research work in cancer control.

Dr Wood is a past-president of the Radiological Society of North America, and to his constructive work while President the Society owes much of its present success. His friends congratulate him and all radiologists can well feel gratification in each new honor that comes to Dr Wood, knowing that it is truly earned.

ROYAL SOCIETY OF EDINBURGH

A David Anderson-Berry Gold Medal, together with a sum of money amounting to about £100, will be awarded in July, 1938, by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the nature of x-rays in their therapeutic effect on human diseases. A similar award will be made every three years.

Applications for this prize are invited. They may be based on both published and unpublished work and should be accompanied by copies of the relevant papers.

Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh, 2, by *June 1, 1938*.

This announcement was first published in the March, 1937, issue of RADIOLOGY, page 373, and is here repeated by request.

IN MEMORIAM

WILBUR S. WERNER

Mr Wilbur S. Werner, well known to many members of the Radiological Society of North America as president of the Kelley-Koett X-

antrum in the completely sclerosed mastoid measures 6 mm transversely by 10 mm vertically, an increase in size beyond these limits may be attributed to eroding cholesteatomas

J E HABBE, M D

ENCEPHALOGRAPHY

Tumor of the Brain, with Normal Encephalogram
Nathan Savitsky and Morris B Bender *Am Jour Med Sci* July 1937, 194, 96-103

In a series of 500 tumors of the brain these authors found 120 patients with intracranial air injections, seven showed normal aerograms. These with two other cases, constitute the basis for the present report. The series indicates that brain tumors, irrespective of their location, nature, size, and rate of growth may exist for a long time without significant alterations in the ventricular and subarachnoid spaces. Of the nine cases reported tumors were found in the parietal lobe in three, in the frontal lobe in four and in the corpus striatum and temporal lobe in one and in the basal ganglia in one. The duration of the course of the disease varied from two months up to 19 years, until the time a normal encephalogram was found. In four instances, papilledema was present.

Emphasis is placed upon the facts that during earlier stages of a brain tumor the aerograms may be negative, that normal ventricular and subarachnoid systems may exist irrespective of the nature and location of the tumor and the duration of its course, and that a negative encephalogram does not exclude the diagnosis of a tumor based on clinical grounds.

W A SODEMAN, M D

THE ESOPHAGUS

Narrowing of the Inferior Esophagus as a Clinical Entity
A Soulas *Arch d mal de l'app digestif* March 1937, 27, 299-313

A Soulas discusses the narrowing of the esophagus at the cardio-esophageal junction. He believes such narrowings can be classed as accompaniments of mega-esophagus due to hypertrophy of the sphincter, or as stenosing inflammation of the musoca muscularis extending to the mucosa and accompanied by inflammatory edema and purulent exudate with later fibrosis.

He cites the symptomatology and the clinical, radiologic and esophagoscopy findings in a number of cases and discusses the therapy.

S RICHARD BEATTY, M D

Cancer of the Esophagus Treated by Deep X ray Therapy
Herbert Tilley *British Med Jour* June, 1937 pp 1199-1200

This case report describes a patient with cancer of the mid third of the esophagus treated by a technique permitting entry of the rays through six long narrow fields centered over the esophagus. Such a method the author states produces good palliative results in over 60 per cent of the cases. The mid third growths

do very well for a time, a year or two, but death ensues within two and a half years.

In the present case the patient lived two years and eight months and was entirely symptom free for one year and eight months, with little difficulty for a further period of eight months.

W A SODEMAN, M D

GALL BLADDER (NORMAL AND PATHOLOGIC)

The Influence of Extra biliary Disease on the Function of the Gall Bladder. A Cholecystographic Study
C Allen Good, Jr, and B R Kirklin *Am Jour Roentgenol and Rad Ther*, March, 1937, 37, 346-349

In 733 patients with diagnoses such as peptic ulcer, pernicious anemia, thyrotoxicosis, myxedema, diabetes mellitus, obesity, pulmonary tuberculosis, or chronic appendicitis, the gall bladder was examined with the oral dye. In 167 that organ was found functioning poorly or not at all. Of those, 106 were examined by operation or at autopsy and 104 were found to be diseased, thus proving that extra biliary diseases have little or no influence on the cholecystographic function of the gall bladder.

S M ATKINS, M D

Cholecystography. The Efficiency of the Graham-Cole Test
T Garratt Hardman *British Med Jour*, Oct 16, 1937, pp 733-734.

Hardman found in his cases that the oral method of cholecystography indicated in 90 per cent of the cases whether the gall bladder was normal or pathological. The fact that 10 per cent of errors may occur is good reason for urging that the Graham-Cole test should not be used to supplant the usual clinical methods of examination but should take its place as part of the ordinary routine investigation as a valuable aid in the diagnosis of cholecytic disease. The success of the method depends upon the most careful attention to detail in preparation and to correct radiographic technique.

G E BURCH, M D

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Chronic Non specific Regional Ileocolitis
C J Hansson *Acta Radiologica*, August 1937 18, 635-642

Hansson discusses the clinical and pathological picture of regional ileocolitis. Roentgenologically he finds with the aid of contrast lavages a normal mucous membrane of the colon instead of an absence of the mucous-membrane relief characteristic of colitis. However in more advanced cases alterations may be observed in the cecum and may even extend up the ascending colon. The alterations are characterized by a smooth, cornet-shaped constriction of the lumen down to the valve of Bauhin. The alterations may be of such a degree that the lumen becomes as narrow as a string often referred to as the string sign in American literature. The

ness is weakened by the appearance of their having been obviously retouched. The plates are accompanied by good, short abstracts of histories. Many pictures are shown which illustrate various typical features of senile and presenile arteritis (arteriosclerosis obliterans), although very few show the lower portion of the leg and the foot. Only two cases of thrombo-angitis obliterans are illustrated and these do not emphasize the typical arteriographic findings in this disease. Only one arteriogram of a patient with Raynaud's disease is shown and this is reduced too much to show the digital arteries. There are several good plates of arterial aneurysm and one of an arteriovenous fistula. The author also attempts to show distinguishing arteriographic findings in association with certain bone tumors. Four arteriograms of the abdomen, taken after injection into the aorta, are shown. The author feels that arteriography gives valuable information regarding confirmation of the clinical diagnosis of arterial diseases and regarding the extent and localization of arterial occlusions, of parietal arterial lesions, and of tumors and lesions of the bones of the extremities.

SYNOPSIS OF DIGESTIVE DISEASES By JOHN L. KANTOR, Ph.D., M.D., Associate in Medicine, Columbia University, Gastro-enterologist and Associate Roentgenologist, Montefiore Hospital for Chronic Diseases, New York. A volume of 302 pages, with 40 illustrations. Published by the C. V. Mosby Company, St. Louis, Missouri, 1937. Price \$3.50.

The object of Kantor's book, according to the preface, is "to present simply, clearly, and concisely the essential facts concerning the diseases of digestion." It is obviously extremely difficult to accomplish this purpose in 286 pages, and there naturally will be certain shortcomings in that it is impossible to give to individual diseases which are important the space they require to properly bring out factors of importance. The book is an attractive one which is arranged artistically. The division of the material included is done in an orderly manner.

The book is divided into four parts, the first dealing with the classification of digestive disorders, diagnostic and therapeutic methods, and a discussion of constitutional inferiority, and gastro-intestinal allergy. In the second portion is a discussion of disease which includes

the biliary system as well as every portion of the intestinal tube from the mouth to the anus. All of these diseases are covered in 184 pages, a formidable task indeed, but one which Kantor accomplishes with a surprising degree of completeness. Part III includes a consideration of digestive symptoms and extra-digestive diseases. This part is hung on as a sort of suffix and could be done with more completeness. Kantor's book is one which because of its completeness, attractive editing, and orderliness should appeal to any physician who has any interest whatsoever in the digestive tract.

DIE BIOLOGISCHE BEDEUTUNG DER INFRA-ROTEN STRAHLEN (The Biologic Significance of Infra-red Rays) Also Supplement 1 of Volume 4 (1937) of *Helvetica Medica Acta*. By O. MERKELBACH. A volume of 64 pages, with 29 illustrations. Published by Benno Schwabe & Company, Basel, 1937. Price Swiss Fr. 4.00.

A critical review of the literature dealing with the biologic effect of infra-red rays convinced the author that very little reliable information exists and that, above all, the fundamental physical data are entirely lacking. He studied, therefore, especially the infra-red spectra of a number of compounds, beginning with water, chloroform, alcohol, amino acids and ending up with hemoglobin, its derivatives and also chlorophyll. The methods employed are described and the advantages and disadvantages of thermo-spectrography and photo-spectrography discussed. The results of the experiments seem to indicate that infra-red rays of 0.76-1.0 μ may produce biologic effects in connection with local or systemic sensitization. A short chapter dealing with infra-red photography is included.

The study of this monograph must be considered a necessity by all those who wish to investigate the clinical aspect of infra-red therapy.

SOME QUANTITATIVE ASPECTS OF THE BIOLOGICAL ACTION OF X- AND GAMMA-RAYS By C. M. SCOTT, M.D., issued by Medical Research Council, Special Report Series No. 223, London, 1937. A volume of 99 pages. Price 1 shilling, 6 pence.

This short monograph in pamphlet form is divided into two parts. In the first portion the author briefly summarizes and analyzes the

antrum in the completely sclerosed mastoid measures 6 mm transversely by 10 mm vertically, an increase in size beyond these limits may be attributed to eroding cholesteatomas

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bibliography Without this essential chapter the book would lose much of its importance as a great book of reference

The student will find that the chapter entitled "Physiological Principles of Collapse Therapy" will help in understanding the responses of lung following operation, and especially the compensatory mechanisms brought into play when the lung is reduced in volume by collapse. The physiologic responses to each variety of condition are described separately and include such effects as those of muscular compensation, effects on the circulation, changes in flow of lymph, the occurrence and significance of air embolism and pleural effusion, and the extent of respiratory embarrassment incidental to decrease of vital capacity.

The indications for each type of operation employed in bringing about and maintaining satisfactory collapse are discussed in a separate chapter. As a supplement there is added a reference guide consisting of eighty-four diagrams representing the principal types of pulmonary and pleural lesions for which collapse therapy may be used. Each legend indicates briefly the operation or sequence of operations to be used in treatment.

In descriptions of both minor and major operations, great care is taken in describing, not only the operative technic, but pre-operative preparation, accidents that may be encountered, and the most approved methods of combating them. Post-operative management meets with an equally careful consideration and, finally, the results obtained from each method of operative attack are discussed frankly.

Physicians will welcome this book because of the help given in the discussion of physiologic effects entailed and the statistical evidence of the value of the several methods of treatment. Surgeons will welcome it for the same reasons, but, in addition, will find it of greatest service not only in forming conclusions with reference to choice of operations in particular cases, but also in the guidance in technic suggested.

Perhaps the book might be criticized because of size rather than content. Yet it is difficult to choose the subject matter that might be deleted and still have what it is designed to be: a book of reference for students of tuberculosis.

RADIATION THERAPY Its Use in the Treatment of Benign and Malignant Conditions
By IRA I. KAPLAN, M.D., Clinical Professor of Surgery, New York University Medical College, Director, Radiation Therapy Department, Bellevue Hospital, New York, Director, Division of Cancer, Department Hospitals, City of New York, Director, New York City Cancer Institute, Associate Radiologist, Lenox Hill Hospital, New York, Editor (Therapeutic Section) "Year Book of Radiology." A volume of 558 pages, with 198 illustrations. Published by the Oxford University Press, New York City, 1937. Price \$10.00.

One could guess that a text on radiotherapy written by one with Kaplan's experience and knowledge of the world's literature would be an outstanding one. It is, and Kaplan deserves sincere congratulations for so ably handling the vast subject of radiotherapy. Although the book is written for students and practitioners, the radiotherapist will do well to look it over as a 'refresher.' Of course, one could find fault with some details such as the length of the presentation of gynecologic and the brevity of the consideration of inflammatory and neurologic lesions, but Kaplan decided on this allotment of space after far more thought than this reviewer used in this criticism. Many things recommend the book, its whole set-up, the illustrations, the index, the omission of statistics and voluminous literature, and especially the presentation of the treatment of oral, mammary, uterine, and rectal carcinomas. Braestrup is to be particularly commended for his chapter on the Physics of Radiation.

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THE CLINICAL AND ROENTGENOLOGIC MANIFESTATIONS AND SURGICAL TREATMENT OF DIAPHRAGMATIC HERNIA, WITH A REVIEW OF 131 CASES¹

By STUART W HARRINGTON, M D , Division of Surgery, and B R KIRKLIN, M D ,
Section on Roentgenology, The Mayo Clinic, Rochester, Minn

It is gratifying to have the opportunity to present the subject of the diagnosis and surgical treatment of diaphragmatic hernia before this Congress because roentgenography plays an important rôle in the recognition and differential diagnosis of diaphragmatic hernia. It is also of great value in determining the size and situation of the defect in the diaphragm, which is of aid in determining the method of surgical treatment to be instituted.

The incidence of diaphragmatic hernia is probably no greater now than it was twenty years ago, at that time the condition was thought to be uncommon, and its recognition in life was rare. More frequent recognition of the condition in the last two decades has been attributable primarily to development of roentgenologic methods of diagnosis. The clinical study of proved cases has established a fairly definite symptomatology which has enabled the clinician to diagnose the condition or to suspect the presence of a hernia and to have a special roentgenologic examination made. It will scarcely be claimed that the entire credit for the present more frequent recognition of this condition is due the roentgenologist, but he is entitled to share this credit with the clinician. A

greater proportion of the responsibility for the establishment of the correct diagnosis must rest on the clinician, for he is first to come in contact with the patient, and the subsequent course of the examination and treatment depends on his interpretation of symptoms.

The more frequent recognition of diaphragmatic hernias in recent years is exemplified by reviewing the cases encountered at The Mayo Clinic between 1900 and 1937. From 1900 to 1925, 30 cases were recognized clinically and 19 patients were operated on, from 1925 to 1937, 211 cases were recognized and 131 patients were operated on. This shows that seven times as many cases were recognized in the last 12 years as in the previous 24 years. We believe that the condition is more common than the present records indicate, for one of us (S W H) has examined the diaphragm in the course of other abdominal operations and occasionally has found a small hernia that had not been recognized clinically or roentgenologically before operation.

CLASSIFICATION

Because of the various structures which are often involved in the hernia the symptoms are complex. They depend on the amount of mechanical interference with

¹ Read by Dr Harrington before the Fifth International Congress of Radiology, Chicago Sept 13-17, 1937

ANIMAL EXPERIMENTATION

Radiation Injury of the Sperma of Mice and Rats as Observed on the Early Development of the Ova H Brenneke *Strahlentherapie* 1937, 60, 214

The testicles of adult mice and rats were irradiated with roentgen rays, 800–2,200 r were given to mice and 800–1,800 r to rats. The effect on the mature sperm cells was studied by observing the impregnated ova of female animals. It appeared that the fertility of the sperma stored in the epididymis is not influenced by irradiation. The percentage of non impregnated ova was 7.39 per cent for mice and 5.25 per cent for rats. The fertile period of the mouse after irradiation lasts approximately two weeks regardless of the dose applied. Some of the impregnated ova showed abnormal development and in some cases abortion occurred. There was a definite difference in the susceptibility of the two types of animals because following irradiation with 800 r, 80 per cent of the ova of rats and only 65 per cent of the ova of mice showed normal development. In conclusion the author warns again against indiscriminate exposure of the generative organs in man.

ERNST A. POHLE M.D., Ph.D.

Experimental Contribution to the Problem of the Time Factor H Kirchhoff and W. Kelbling *Strahlentherapie*, 1937 60, 444

The authors exposed the testicles of 14 adult rabbits one was treated by fractional doses the other by protracted fractional doses. Technique 170 kv, 1.2 mm Cu + 1 mm Al and 180 kv, 0.7 mm Cu + 1 mm Al. The focal skin distances were 20 and 125 cm. The single doses 200 r (in air) were given at intervals of 24 hours. In a few instances single doses of 30, 40 and 50 r were used while the total dose varied from 300 to 1,800 r. This allowed a ratio in the r/min. from 1.5–1.39. The animals were killed from four to 43 days after the last exposure. Careful histological examinations of the testicles treated with both methods showed that the effect of the protracted fractional irradiation was not greater than that of the simple fractional dose method. It is emphasized however that these results which have been obtained on normal tissue may not be transferred to malignant tumors in humans.

ERNST A. POHLE M.D. Ph.D.

ARTERIOGRAPHY

Diagnostic and Therapeutic Relation of Arteriography R. Demel and M. Sgaltzer *Wien klin. Wchnschr.*, May 7, 1937 50, 595–596. (Reprinted by permission from *British Med. Jour.* June 26 1937 p. 103 of *Epitome of Current Medical Literature*.)

The authors stress the therapeutic value of arteriography in cases of endarteritis obliterans, Raynaud's disease, arteriosclerosis, thrombosis, etc. apart from the important diagnostic value of the method. In a number of cases they were able to observe a remarkable improvement in the condition of the limb following an

intra-arterial injection of 20 c.c. of a 20 per cent solution of perabrodil. They explain the favorable therapeutic result by a persistent dilatation of the arterioles following the injection. The injection can be repeated after some time if necessary.

BIOLOGIC EXPERIMENTATION

The Biologic Effect of Continuous and Periodically Interrupted Roentgen Irradiation upon the Eggs of the Fruit Fly A. Gregori *Strahlentherapie* 1937 60, 422

The author compared the biologic effect of roentgen rays on the eggs of the fruit fly if they were applied either in the form of a continuous exposure or by periodically interrupted exposures. Technique 180 kv, 15 ma, 0.35 mm Cu + 0.5 mm Al 6–417 r/min. By means of a rotating disc the interrupted exposures gave doses equal to the continuous exposure of 50 and 2½ seconds from 180 to 5 seconds. The experiments showed that by decreasing the number of r per minute for continuous exposure the biologic effect is definitely decreased. If the eggs were irradiated with a high number of r/second at the same time increasing the time of exposure without changing the doses by means of periodical interruptions of the irradiation the biologic effect was not the same as that obtained with continuous exposure during the same time. It could be demonstrated that in such case it was greater and corresponded to the effect produced with continuous irradiation and a high number of r/min. The experiments were carried out with the ratio of 1:3 between intensity and time.

ERNST A. POHLE M.D. Ph.D.

THE BLOOD

The Effect of Radium and of Benzol on the Blood and Blood-forming Organs with Special Consideration of the Leukocytes A. Feller *Strahlentherapie* 1937, 60, 393

The author studied the toxic effect of radium and benzol on the blood and blood-forming organs in rats. Both produce changes in the total number and the percentage distribution of leukocytes. These changes as well as the histological findings in the various organs were very similar following radium exposure and benzol administration. However, regeneration set in much earlier following benzol as compared with radium. So far it is impossible to determine whether or not the observed changes are due to a direct effect of benzol and radium on the leukocytes or due indirectly to an injury of the blood-forming organs.

ERNST A. POHLE M.D. Ph.D.

BONE DISEASES (DIAGNOSIS)

Non-specific Osteitis of the Ribs Kárc T. Poulsson *Acta Radiologica* August 1937 18, 643–651

Osteitis of the ribs occurs principally as two chronic specific infections: tuberculosis and syphilis. Of these

particular surgical significance because, in 21 of the cases, the patients had been operated on previously for other conditions, without complete relief of symptoms, and were completely relieved following repair of the hernia. Of these 21 patients, eleven had undergone cholecystectomy previously, four, cholecystostomy, three appendicectomy, two, pyloroplasty, and one gastroenterostomy. Five of these patients, two who had duodenal ulcer and three who had gallstones, were partially relieved of symptoms but continued to have distress from an unrecognized para-esophageal hernia. This emphasizes the importance of having roentgenologic studies made of the stomach to rule out the presence of a para-esophageal diaphragmatic hernia in cases in which indefinite clinical symptoms are referable to the upper part of the abdomen.

The gross diaphragmatic hernias, especially those in which a large segment of the stomach or bowel protrudes into the thoracic cavity, are strikingly manifest at roentgenologic examination, and often the diagnosis is self-evident. But frequently despite pronounced alterations of the thoracic picture, the diagnosis cannot be established without critical study, and small or reducible hernias are likely to escape discovery unless the examiner is alert for clues that will stimulate thorough search.

Among signs suggestive of hernia that may be elicited during the routine examination of the stomach, displacement of the lower segment of the esophagus is particularly significant and of common occurrence. In many cases, as the bariumized mixture passes down the gullet it becomes evident that the lower portion of the esophagus is displaced mesially and describes a hook-like curve. In other instances the terminal segment is tortuous but not dilated. In still other cases the segment is angulated. Shortening of the esophagus is obvious in the rare cases of congenital shortening. Undue retardation of the barium stream at the hiatus is another potential index of hernia and occurs in many cases.

Scarcely second in importance among

signs suggestive of hernia is the observation that the level of the gastric contents is above that of the esophageal aperture. Diaphragmatic hernia is the most probable cause, and this sign aids in distinguishing hernia from eventration, for in the latter condition the two levels coincide. What apparently is high hour-glass contraction of the stomach with a visible niche at the site of constriction is, in fact, often hernia of the stomach through the diaphragm, and the ulcer is merely a complication. In many cases of hernia the symptoms are chiefly or solely thoracic and roentgenologic examination of the thorax is demanded first. Here again hernias involving the stomach and colon may be obvious, but in many cases the manifestations, though pronounced, are not diagnostic. In such cases hernia should always be taken into consideration and appropriate examination should be requested.

Reducible hernias, such as the para-esophageal variety, can usually be revealed at examination in the vertical position by pressing the stomach upward, or suspected by the presence of one or more of the signs already described, but trochoscopic examination is always necessary to confirm the diagnosis and to determine the extent of herniation. In no instance can hernia of the colon be excluded confidently without employing the barium enema, and when only the small bowel is implicated, repeated observations after an opaque meal are necessary for diagnosis. In the rare cases of hernia through the right arch of the diaphragm, a portion of the liver usually projects through the breach and is likely to be mistaken for a neoplasm. On the whole, however, few diaphragmatic hernias should elude roentgenologic disclosure and specific diagnosis.

In a general way the clinical syndromes associated with various types of diaphragmatic hernia can be divided into two main classes, depending on the abdominal viscera which are involved in the hernia. The first class consists of those cases in which the stomach is the only abdominal viscus incorporated in the hernia. In these cases

6 × 8 sq cm As many areas as feasible were irradiated, as a rule four or five small areas The doses applied fluctuated considerably, beginning with 400-500 r, the total doses reached in some patients over 32 000 r In a few instances the method of Wintz and Holfelder was employed giving in from eight to ten days about 2 000 r total surface dose The end results are tabulated offering also a brief analysis of the clinical data for each patient The best results are apparently to be expected from a combination of operation and irradiation Partial removal of the tumor should be followed by courses of intensive radiation therapy

ERNST A POHLE M D Ph D

BREAST CANCER

The Post-operative Irradiation of Cancer of the Breast H Bade and K Baden *Strahlentherapie*, 1937, 60, 189

The authors describe the method developed by Meyer in the post-operative irradiation of carcinoma of the breast Moderate doses are used, being given over a two year period following operation at increasing intervals Ten to twelve series of 50-60 per cent H E D are administered During the period from 1921 to 1933 a total of 105 cases were treated, 43 of these were in Stage I, 42 in Stage II, and 20 in Stage III The respective percentages of five year survivals were 65.3, 35.7 and 10 per cent, or a total of 42.8 per cent for all treated cases In conclusion the authors stress the importance of close co-operation of surgeon, pathologist and radiologist

ERNST A POHLE, M D, Ph D

CANCER (DIAGNOSIS)

The Problem of Cancer Families" R Werner *Strahlentherapie* 1937 60, 184

The author analyzes 15 cancer families" and found that among 104 members 58 developed cancer Cancer of the stomach showed the highest incidence

ERNST A POHLE M D Ph D

CANCER (THERAPY)

The Results of Several Years' Roentgen Therapy with Small Focal Skin Distance in Carcinoma of the Skin and Lip H Chaoul K Greinader and H Oeser *Strahlentherapie* 1937, 60, 239

The authors' method of applying roentgen rays of moderate potential, fairly heavy filter, at very short focal distance has been described repeatedly In this article they relate the results obtained with this method during the last three years They treated 171 skin cancers 85.3 per cent have remained well over a three-year period The percentage for 42 cases with cancer of the lip was 83.3 per cent They also quote several other investigators who report similar results with this method The doses applied varied from 5 000 to 10 000 r In conclusion the authors state that this method of roentgen therapy compares well with radium

ERNST A POHLE M D Ph D

The Co-operation of the Hospital in the Fight against Cancer H Holthusen and A Hamann *Strahlentherapie*, 1937, 60, 70

This is a statistical analysis of the patients admitted to the St George Hospital in Hamburg with the diagnosis of tumor during the period from 1931 to 1935 The tabulations show the distribution of the tumors as to localization, morbidity statistics, the type of treatment received in the hospital, and the age distribution The operation of the social service division is also discussed

ERNST A POHLE M D Ph D

DIATHERMY

The Qualitative and Quantitative Differences in the Radiation Emitted between Natural Sun and Therapeutic Lamps Description of a New Lamp Emitting Practically the Same Spectrum as the Sun E Witte *Strahlentherapie* 1937 58, 113

The author describes briefly an artificial source of light the spectrum of which approaches that of the sun especially if combined with a quartz mercury vapor lamp filtered through uvioil glass The latter removes ultra violet rays below 2 700 Å The lamp consists of five nuphot glow bulbs of 500 watts each It uses a water filter of 1 cm thickness so cooled as to keep its temperature always under 40° C In a short paragraph some of the preliminary clinical observations are described

ERNST A POHLE, M D, Ph D

DOSAGE

Influence on the Biologic Object of Rhythmic Interruption of Roentgen Irradiation P Zacharias *Strahlentherapie* 1937 59, 224

The author exposed seedlings of *Vicia faba equina* to roentgen rays using the protracted fractional dose method and exposure interrupted at regular intervals His apparatus allowed 10 seconds of irradiation followed each time by 20 seconds at rest This type of application seems to be better tolerated than continuous irradiation provided of course that in both instances the same total time was used

ERNST A POHLE M D Ph D

THE EAR (MIDDLE)

Cholesteatoma in Chronic Otitis Media A S MacMillan *Am Jour Roentgenol and Rad Ther* December 1936 36, 747-750

The fronto-occipital position is advocated for showing the smooth rounded and multiloculated cavities occurring in the middle ear attic or mastoid antrum with the Law mastoid projection also being employed to aid in differentiating large emissary veins and deep lateral sinus grooves The density of the cholesteatoma compared with the surrounding dense bone is negligible hence films taken after operative removal of the cholesteatoma will present the same appearance as before removal The average size of the mastoid

in the hernial opening. They are usually relieved by belching of gas and vomiting and are commonly considered to be attributable to cholecystitis, for which the patient is usually treated. As more of the stomach becomes incorporated in the hernia, the attacks become more severe, the pain is projected straight through to the back and to the lower left side of the thorax, is more marked to the left of the spinal column and often appears between the shoulder blades. This pain may be agonizing, and there is difficulty in belching of gas and vomiting because of spasm of the diaphragm and reflex cardiospasm. The spasm of the diaphragm produces an hour-glass deformity of the stomach, which interferes with emptying of the upper loculus and causes increased intragastric pressure. The pressure of the herniated portion of the stomach on the lower part of the esophagus interferes with belching of gas or vomiting.

Spasm of the diaphragm is commonly associated with phrenic pain which is referred to the left shoulder and which at times may extend down the left arm. The increased pressure within the thorax causes cardiac embarrassment, with palpitation and tachycardia. Pressure on the lung and interference with the motion of the diaphragm cause dyspnea. These symptoms are augmented when the patient lies down, and in the more severe cases it is necessary for patients to sit up to breathe. The attacks may last for from a few minutes to several hours, and not uncommonly are considered to be caused by myocardial disease, relative to which the most frequent diagnosis is that of angina pectoris. The attacks often recur immediately after food has been taken. There is often an interval of weeks or months between attacks. It is probable that during the interval between attacks the stomach is not incorporated in the hernial ring and is in its normal position below the diaphragm. When the attacks become more or less constant, the stomach usually has become fixed in the thorax by adhesions. All the early symptoms of pressure are augmented during attacks. There

is loss of weight from inability to retain food and from marked restriction in diet because of the fear of bringing on an acute attack of gastric obstruction. This may be termed "food-fear."

The vomiting is more severe during attacks and often is of the retention type. During the severe vomiting the vomitus may contain blood. If the attacks are of long standing, the patient not uncommonly has a burning sensation in the epigastrium after meals, which is relieved by taking small quantities of food. If a large amount of food is taken it may bring on one of the attacks associated with incarceration of the stomach. Many of these patients present a fairly good syndrome of ulcer, are given medical care, and obtain partial relief because they have taken a restricted amount of food at frequent intervals.

Hemorrhage is not a common symptom, it usually is indicative of severe incarceration, with fixation of the stomach in the thorax. The bleeding is caused by erosion or ulceration of the mucous membrane, resulting from the forceful pressure exerted during the attacks of vomiting on the large, distorted and congested stomach and to the trauma caused by the hernial ring as the stomach is forced in and out of the opening. This erosion may be superficial, or, in cases of long-standing, definite ulceration may form from repeated trauma. This is usually the final stage of incarceration. Strangulation of the stomach as a result of hernia has not been observed at the clinic and it is to be doubted that strangulation is possible because of the powerful musculature and rich blood supply of the gastric wall. Because of the fixation of the stomach in the thorax, the obstruction may be complete, and the vomiting may be so severe as to produce gastric tetany.

Patients who have para-esophageal hernia, of which the predominating symptoms are those of esophageal obstruction, are of particular interest and require careful clinical study. The symptoms may be attributable to an entirely unassociated lesion of the lower part of the esophagus, such as cardiospasm, carcinoma, or diverticulum,

narrowing is produced by infiltration of the intestinal wall, which progressively diminishes as it extends up the ascending colon. The intestine is smooth in contour. The valve of Bauhin is constricted thus frequently making it difficult to determine where the ileum ends and the colon begins. It is also difficult to force the contrast medium past the colon into the ileum. Infiltration of the wall of the terminal portion of the ileum and cornet-shaped stenosis toward the valve of Bauhin are observed embracing about the terminal 15 to 20 cm of the ileum. In this altered area one palpates a tender tumor and a fixed or slightly displaceable intestine. On passage examination one usually observes dilation of the healthy intestine above the altered area together with slowing down of the passage through the small intestine.

G E BURCH M D

Diverticula of the Digestive Tract. Friedrich Ueber. München med Wehnschr. Aug 27, 1937, 84, 1377.

A rather brief monographic exposition of the symptoms, diagnosis, treatment, and prognosis of traction and pulsion diverticula of the esophagus, diverticula of the stomach and duodenum of the colon and Meckel's diverticula. No new material is presented. The article is illustrated and case reports amplify the descriptions.

LEWIS G JACOBS M D

Discussion on Some of the Less Common Lesions and Special Methods of Investigation of the Alimentary Tract and the Influence of Adjacent Organs. C Gage, S C Shanks, R S Paterson and G Bush. Proc Royal Soc Med, September, 1937, 30, 1371-1392.

The subjects of the symposium are briefly discussed and include the salient roentgenographic features of the diseases which aid in diagnosis. The conditions presented were sarcoma of the stomach, polyposis of the stomach, retroperitoneal hernias, primary carcinoma of

the duodenum, Crohn's disease and *Ascaris lumbricoides*. Unusual methods of examining the pharynx, esophagus, stomach, pancreas, small intestine, and colon, roentgenologic examination and features in diseases of the colon, and the influence of adjacent organs and tumors on the alimentary tract are also discussed.

G E BURCH M D

GENITO-URINARY TRACT (DIAGNOSIS)

Congenital Abnormalities in the Urinary Tract of a Six Year-old Child. M Bernasconi. Bull et Mém Soc Radiol Méd de France, February 1937, 25, 154-155.

The author reports a case of a child six years of age who had a right-sided mega ureter with hydronephrosis and vesico-renal reflux on the left despite a normal ureteral orifice. The position of the pelvis and ureters led to the diagnosis of horse shoe kidney.

S RICHARD BEATTY, M D

GENITO-URINARY TRACT (THERAPY)

Effect of Various Wave Lengths on the Aschheim-Zondek-Friedmann Reactions. T M Caffaratto and M Bertini. Strahlentherapie, 1937, 59, 276.

The authors studied the effect of infra-red rays, ultra-violet rays and roentgen rays (170 kv, 3 ma, 30 cm FSD, 1 mm Al, 300-3600 r) on the Aschheim-Zondek-Friedmann reaction. Urine of pregnant women at the beginning and end of the pregnancy was used. They found that the reaction was more pronounced if the urine had been exposed to the roentgen and infra-red rays while ultra-violet rays seemed to depress it. From a practical standpoint they suggest irradiating the urine specimen since the reaction is not only more pronounced but occurs sooner than under ordinary conditions—in many instances as early as 24 hours after the injection.

ERNST A POHLE, M D Ph D

surgical methods and some of the special technical considerations which are required in some types of hernia will be discussed.

There is only one type of diaphragmatic hernia that may be treated conservatively and that is hernia through the esophageal hiatus, when only a small portion of the cardiac end of the stomach is involved in the hernia and then only when the symptoms are mild. If symptoms become progressively more severe, the possibility of serious complications is great, and treatment in all such cases should be surgical, unless radical operation is contra-indicated because of the patient's general condition. Operation should be performed before severe incarceration, with consequent obstruction and traumatic lesions of the stomach, have occurred. The operative risk is increased by gastric retention, and the technical difficulties are enhanced by fixation of the stomach to the diaphragm and to the hernial sac within the thorax.

All cases in which the colon or small bowel are involved in the hernia demand early operation because of the danger of intestinal obstruction. However, these cases are usually traumatic in origin and it is best not to operate until the acute symptoms caused by the primary injury have subsided if the patient's condition will permit.

Interruption of Phrenic Nerve —Paralysis of the diaphragm, produced either by temporary or permanent interruption of the phrenic nerve, is of value as a procedure preliminary to radical operative repair of many different types of diaphragmatic hernia. It is a necessary procedure in the surgical treatment of partial thoracic stomach resulting from a congenitally short esophagus. In some cases in which radical operative repair is contra-indicated it may be used as a palliative measure. In most instances interruption of the phrenic nerve is utilized as a procedure preliminary to radical operative repair of the hernia.

RADICAL SURGICAL REPAIR

Anesthesia —Ethylene or cyclopropane is preferable as the anesthetic agent, and

the method of administration depends on the type of hernia which is present. In all cases in which there is no hernial sac and in which there is a direct communication between the abdominal and thoracic cavities, intratracheal administration of the anesthetic agent by means of a positive pressure machine is preferable. In cases in which there is a hernial sac, as in the para-esophageal type of hernia, the anesthetic agent can be administered by the closed-mask method.

General Technical Considerations —Both the abdominal and the thoracic approach in reduction and repair of these hernias have been employed. In two cases in which the thoracic approach was used it was necessary to resort to a combined thoracic and abdominal procedure in order to free the adherent abdominal viscera from the abdominal side of the diaphragm, if repair was to be accomplished without injury to abdominal viscera. In one of these cases post-operative empyema developed, necessitating drainage and resection of a rib before ultimate recovery could take place.

In treatment of all hernias through the left hemidiaphragm, the abdominal approach through an oblique left rectus incision is preferable, starting at the ensiform cartilage and extending to the outer border of the rectus muscle. There is less risk of thoracic complications when this approach is used. It is of particular advantage in cases of esophageal hernia, for the herniated stomach is usually confined in a sac in the posterior mediastinum and does not enter the true pleural cavity.

In hernias through the right hemidiaphragm, the thoracic approach is chosen because the large, right lobe of the liver makes the abnormal opening in the diaphragm inaccessible from the abdominal approach.

The technical difficulties of adequate exposure of the hernial openings through the left hemidiaphragm and the esophageal hiatus are often considerable because of fixation of the left lobe of the liver to the leaf of the diaphragm. The exposure of

function of the herniated abdominal viscera, on the degree of interference with normal function of the diaphragm, and on the amount of increase in pressure which the herniated viscera produce within the thorax, causing impairment of respiration and circulation

The conditions that influence the symptoms of diaphragmatic hernia depend to some extent on the type of hernia present, whether congenital or acquired, or whether or not trauma has been an etiologic factor

From a clinical standpoint, the history of preceding injury is helpful in establishing the clinical diagnosis and in determining the type, the urgency, and the prognosis of operative treatment. Because of the clinical and surgical significance of trauma as an etiologic factor, one of us (S W H) has suggested that diaphragmatic hernia be classified in two main groups, non-traumatic and traumatic, and have subdivided these according to the various types

A non-traumatic diaphragmatic hernia may be congenital or acquired

1 If congenital, the hernia is attributable to embryologic deficiency and usually is without an enclosing hernial sac. The most common sites in the probable order of frequency of occurrence are (1) through the hiatus pleuroperitonealis (foramen of Bochdalek), (2) through the dome of the diaphragm, (3) through the esophageal hiatus, (4) through the foramen of Morgagni, and (5) through the gap left by partial absence of the hemidiaphragm, which is usually in the posterior portion of the muscle

2 If acquired after birth, the sites of occurrence are (1) through the esophageal hiatus, this type has an enclosing hernial sac, (2) through the region of fusion of the anlage of the diaphragm, and (3) at sites named under congenital types

Traumatic diaphragmatic hernia may be caused by direct or indirect injury or by inflammatory necrosis of the diaphragm

1 In indirect injury to the diaphragm, the hernia may occur at any point, including points of embryologic fusion, but the most common region is the dome and posterior

half of the left hemidiaphragm, it may occur in the right hemidiaphragm. It usually is the result of a severe, crushing injury and the hernia may or may not have a hernial sac. When the hernia is through the esophageal opening there is a sac, but when through the leaf of the diaphragm there usually is no sac

2 In direct injury to the diaphragm, the hernia may occur at any point and is usually the result of penetrating wounds, such as those inflicted by a gunshot or a knife

3 Rupture of the diaphragm may be the result of inflammatory necrosis which in turn has been caused by a subdiaphragmatic abscess, or rupture may follow necrosis from drainage tubes introduced into empyema cavities. In these cases the opening in the diaphragm is usually posterior and there is no hernial sac

SYMPTOMS

Recognition of a diaphragmatic hernia clinically is often difficult because of the complex symptoms, which often simulate those of other organic disease of the abdomen and thorax. This, the speaker believes, is one of the most important clinical considerations of diaphragmatic hernia. It is particularly so when the physician encounters those types of hernia which are progressive, and the symptoms of which vary, depending on the degree and type of herniation, so that several clinical diagnoses can be made in the same case because of the changing symptoms. The condition may be termed the "masquerader of the upper abdomen" because the symptoms so frequently simulate those of other disease. In a study of this series of 131 cases it was found that an average of three previous erroneous clinical diagnoses had been made before the correct diagnosis was established. The most common erroneous diagnoses, in order of frequency, were cholecystitis, cholelithiasis, gastric ulcer, duodenal ulcer, hyperacidity, secondary anemia, cardiac disease, cancer of the cardia, stricture of the esophagus, appendicitis, and intestinal obstruction. This was of

COMMENT ON THE OPERATIVE PROCEDURES
EMPLOYED AND ON THE RESULTS IN THE 131
CASES

The operative procedures in the 131 cases on which this paper is based were as follows. In 64 cases the phrenic nerve was either temporarily or permanently interrupted preliminary to operative repair of the hernia. In eleven cases permanent interruption of the left phrenic nerve was done as a palliative measure or as a therapeutic test, in five of these cases, the hernias were para-esophageal and operation was contraindicated, in the remaining six cases, herniation of the stomach was attributable to a congenitally short esophagus for which the procedure was done as a therapeutic test. In these cases it may be necessary to do a radical operation later for complete relief of symptoms. In 120 cases the herniated abdominal viscera were replaced in the abdomen and the abnormal opening in the diaphragm was repaired. In two of these cases a combined thoracic and abdominal approach was employed, in the remaining 118 cases the abdominal approach was employed. In one case a Polya type of gastric resection was done at the time of operation for gastric ulcer high on the lesser curvature of the stomach. In one case posterior gastro-enterostomy was performed for a large duodenal ulcer which had caused almost complete obstruction of the pyloric end of the stomach. In two cases the spleen was firmly adherent to the margins of the opening and to the thoracic portion of the diaphragm, the spleen was torn during operation, which necessitated its removal. In one case, appendicostomy was performed at the time of operation because of marked dilatation of the colon which had resulted from partial obstruction during the time it was in the thoracic cavity. In ten cases there was moderate congenital shortening of the esophagus associated with the hernia, the diaphragm could be sutured entirely above the stomach after the diaphragmatic muscle had been paralyzed by phrenicotomy. In one case, extra-pleural thoracoplasty was per-

formed preliminary to repair of the hernia. As noted in the first part of this paper, 21 of these patients had prior operations for the same complaint, without relief of symptoms, but were completely relieved following repair of the hernia.

There were seven deaths following operation, five of them occurred in cases of congenital hernia and two in cases of traumatic hernia. Four deaths occurred in the first 72 hours from respiratory and cardiac failure, three deaths occurred in the second week from pneumonia.

The results obtained in the 124 cases in which the patients recovered from the operation have been reviewed recently by one of us (S W H). Of the eleven patients who were treated palliatively by interruption of the phrenic nerve, one has since died of angina pectoris, four, all of whom were more than seventy years of age, died of causes not definitely ascertained but which apparently were attributable to cardiac conditions, for the patients had myocardial degeneration at the time of the operations. The remaining six of these eleven patients have obtained partial relief of symptoms. One hundred thirteen patients recovered from radical operation for the repair of the hernia, 110 patients have been completely relieved of symptoms and three have had a return of symptoms following recurrence of the hernia. In one of the cases recurrence developed following an influenzal type of pneumonia, three months after operation, the recurrence was caused by the severe strain of coughing. In the other two cases there is no known cause for the recurrence. All patients have been examined roentgenologically every six months to a year after operation.

SUMMARY

The more frequent recognition of diaphragmatic hernia in recent years may be attributed entirely to the development of roentgenography. A study of proved instances of this condition has established symptoms and has enabled the clinician to suspect a diaphragmatic hernia, however, roentgenography is still the most impor-

the hernia is usually para-esophageal. In the second class, the intestines, with or without involvement of the stomach and other abdominal viscera, are included in the hernia. In these cases the hernia usually is of traumatic origin and thus of the acquired type, but may be of congenital origin, in which there is a structural deficiency of the diaphragm.

Para-esophageal diaphragmatic hernia may be considered to be of the non-traumatic congenital or acquired type or it may be considered, in some cases, to be traumatic, but it is essentially congenital. There may be a congenital weakness of the esophageal ring, and a definite hernia may later be produced by some type of injury or by increased intra-abdominal pressure. Recently one of us (S. W. H.) reviewed the results of examination in 1,000 cases in which the esophageal hiatus was examined in the course of other abdominal operations, and in 55 per cent of cases the esophageal ring was closely approximated to the esophagus by loose areolar tissue and there was no appreciable space between the two structures. In 35 per cent of cases at least one finger, or more than one, could be placed between the esophagus and the margin of the esophageal ring. In 8 per cent of the cases two fingers, and in 2 per cent three fingers could be placed between the esophagus and the margin of the opening. When one or two fingers can be inserted between the esophagus and the esophageal ring, the diameter of the hiatus may be considered to be within normal limits. In those cases in which three fingers could be inserted through the opening, special roentgenograms were made subsequently, and in two of these cases a small hernia was found. It is improbable that in all cases in which the esophageal hiatus is enlarged, hernias will ultimately develop, but hernias may develop later if the intra-abdominal pressure is sufficiently increased. Such increase in pressure may be caused by an injury or by any other condition which increases intra-abdominal pressure, such as obesity, pregnancy, severe strain or exertion such as is produced during vomiting or

by violent physical exercise. Hernias following such causes may be considered of traumatic origin but they are essentially congenital, in the same manner that hernias in the inguinal region are congenital.

Para-esophageal hernia is the most common kind of hernia through the diaphragm that is found in adults. It is a true hernia, for a hernial sac is formed of diaphragmatic peritoneum, which fuses with the serosa of the stomach. In most instances this hernial sac is attached to the cardiac end of the stomach, at varying distances from the cardia, which suggests that this kind of hernia is produced by closure of the diaphragm around the stomach before the esophagus has elongated sufficiently to permit the stomach to reach its normal position below the diaphragm, thus producing a large esophageal hiatus. Later the stomach descends to its normal position below the diaphragm and herniates through this enlarged esophageal hiatus. Para-esophageal hernias are slowly progressive and constitute a sliding herniation of the stomach into the posterior mediastinum; they may push into either or both thoracic cavities but do not enter the pleural cavity. The stomach is usually the only abdominal viscus involved in the hernia. These hernias may progress until the entire stomach is contained within the hernial sac, and in these extensive cases the colon and omentum may also be drawn into the sac.

The symptoms of para-esophageal hernia may begin at birth or at any time in life. This kind of hernia produces more uniform symptoms than hernias elsewhere in the diaphragm. The symptoms are those of intermittent, and usually progressive, incarceration and obstruction of the stomach. At the onset, the attacks are usually mild, they consist of epigastric distress that is projected through to the back and comes on in the course of, or shortly after, a heavy meal, but they may be brought on by taking anything into an empty stomach, such as a cupful of coffee. The attacks are usually similar in character but vary a great deal in intensity, depending on the amount of incarceration and fixation of the stomach.

PELVIC ROENTGENOGRAPHY IN PREGNANCY¹

FURTHER EXPERIMENTS WITH 90° TRIANGULATION METHODS

By PAUL C HODGES, PH D, M D, and JANE E HAMILTON, B S, Chicago

From the Division of Roentgenology, The University of Chicago

THE most important roentgenologic contributions to obstetrics are non-quantitative, require little or no special apparatus, and call for only such experience and knowledge as are possessed by all qualified radiologists. Prominent examples of this group are

- (1) Diagnosis of pregnancy
- (2) Differentiation between single and multiple pregnancy
- (3) Diagnosis of fetal attitude, presentation, and position
- (4) Diagnosis of such perversions of pregnancy as ectopic pregnancy, missed abortion, hydatidiform mole
- (5) Demonstration of fetal deformities or disease
- (6) Estimation of amount of amniotic fluid and location of the placenta
- (7) Determination as to whether the fetus is alive or dead
- (8) Thoroughgoing qualitative survey of maternal pelvis

Quantitative studies of the pelvis and fetus require somewhat specialized equipment and experience. One of us (P C H) has recently discussed the general principles underlying all roentgen pelvimetry and fetometry (1) and most of the positions, equations, graphs, techniques, classifications, and special apparatus mentioned in the present paper are illustrated and explained in that article.

OPTIMUM TIME FOR CONDUCTING EXAMINATION OF PELVIS

In cases in which economic conditions permit we recommend examination of the pelvis as soon as possible after the onset of

pregnancy, followed by examination of the fetus *in utero* shortly before term. For the first part of this examination four, or at most six, films suffice, and for the second, two or four, depending on the particular technic employed. Even when one uses the maximum of ten films the amount of radiation absorbed by the skin of the mother is far below the erythema dose and that absorbed by the fetus is very small indeed. There is no reason at all to fear that this small amount of radiation will injure the fetus, and those who have expressed such fears presumably confuse the conditions of diagnostic raying with those of therapy.

The four to six pelvic films made early in pregnancy are distributed as follows:

(A) *Frontal Stereoroentgenograms (Position I)*—These are essential for general survey and classification but are not suitable for measurement of the inlet because of the obliquity of the view.

(B) *A Single Film or Stereoroentgenograms in the Lateral Position (Position II)*—From these one judges the shape and size of the sciatic notch, notes the vertical height of the pelvis, and measures the anteroposterior diameter of the inlet. This diameter as measured on the film is, of course, greater than the true anteroposterior diameter because of triangular distortion. If stereoroentgenograms have been made, distortion may be corrected with the aid of a measuring stereoscope or a stereoroentgenometer or by employing a correction factor obtained from a parallax graph. If but a single film is to be made, it is necessary to measure the distance from the midline of the body to the film at the time the examination is done. This measurement is the object-film distance (*d*) for those anatomical parts lying in the

¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

or they may be the result of ulceration or stricture of the esophagus caused by the hernia. This esophageal ulceration produced by the hernia is attributable to the repeated or constant pressure of the hernial sac on the lower part of the esophagus or to the regurgitation of food or gastric secretion into the lower part of the esophagus. The ulceration may be a small localized lesion or it may involve the entire circumference of the lower part of the esophagus and later may contract and produce a stricture. Because of the possibility of there being a lesion in the lower end of the esophagus caused by or unassociated with the hernia, we believe an esophagosopic examination is advisable in all cases.

The foregoing is the clinical picture in a typical case of slowly progressive herniation of the stomach through the esophageal hiatus, but, of course, it cannot be expected that every case will present all the symptoms, any more than it can be expected that a typical history will be elicited in every case of any other organic condition. The chief symptoms depend, to some extent, on the time in the course of the disease at which the patient is examined, on the rapidity with which the hernia has been produced, on the amount of fixation of stomach in the thorax, and on the amount of disturbed function of thoracic organs.

The symptoms of traumatic hernia or of non-traumatic, congenital types of hernia in which the stomach only is involved in the hernia, are essentially the same as those described but are usually more severe and acute and do not extend over as long a period. Cases of this sort are relatively rare, because in these types of hernia usually the large and small bowel, as well as the stomach, spleen, and occasionally the liver, are involved in the hernia. There is no limiting sac and the herniated abdominal viscera are in direct contact with the lung and pericardium. The condition in these cases may be more properly termed "evisceration of the abdominal organs into the pleural cavity" rather than a "true hernia."

The symptoms in traumatic cases are very rapid in progress and severe in character, and are attributable to the mechanical interference with function of the herniated viscera as well as to marked interference with function of the heart and lungs. The symptoms in these cases are even more severe than those in congenital types of hernia because of the sudden alteration of the intrathoracic pressure as well as the mechanical interference with the function of the organs involved. The most marked immediate symptoms are usually those of respiratory and circulatory embarrassment. Later, severe hemorrhage from the gastro-intestinal tract may occur as a result of incarceration or strangulation of the hollow viscera. If the patient survives the acute condition, the later symptoms depend on the viscera involved. The symptoms may be those of obstinate constipation, the occurrence of large quantities of gas in the colon, and attacks of partial or complete intestinal or gastric obstruction. The sudden onset of symptoms in traumatic cases usually is related directly to the injury and there is rarely any question as to the clinical diagnosis. Surgical treatment is demanded because of the danger of cardiac and respiratory failure or of intestinal strangulation.

SURGICAL TREATMENT

The only treatment of diaphragmatic hernia which will prevent the occurrence of serious complications and assure relief of symptoms is the operative replacement of the herniated abdominal viscera and the repair of the abnormal opening in the diaphragm.

The methods and technic of the surgical procedures utilized in surgical treatment depend on the type, situation, and size of the defect in the structure of the diaphragmatic muscle, the kind and amount of abdominal viscera involved in the hernia, and whether or not the viscera are enclosed in the hernial sac. Details in the surgical treatment of all types of diaphragmatic hernia will not be entered into but general

ESTIMATION OF FETAL AGE FROM AVERAGE CIRCUMFERENCE

Ball has hoped that his measurement of average right-angle circumference might indicate the true size of a fetal skull

like the others has its limitations (Figs 5-d and 5-e)

Further stages in the development of a jacket method of 90° triangulation published by one of us (1) and additional ex-

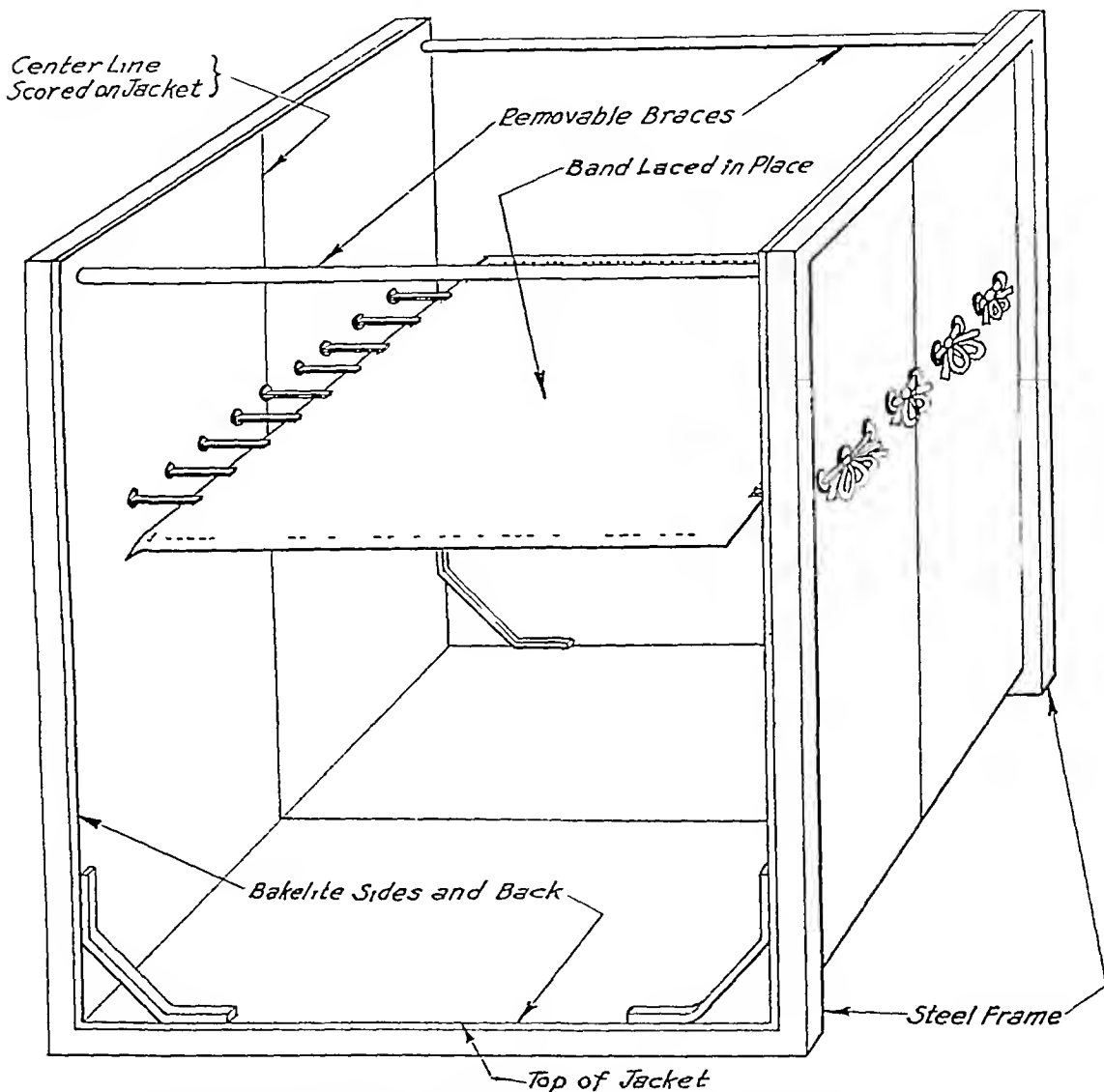


Fig 1 Jacket for 90° triangulation The original jacket was described in detail in an earlier article (1), and the modified jacket illustrated above is described in the text of the present article

regardless of its lie We employ circumference with enthusiasm, believe we have demonstrated its fundamental soundness (1) and find it applicable in many cases where neither occipitofrontal diameter nor biparietal diameter can be measured, but we are convinced that this measurement

periments testing the usefulness of skull circumference as a guide to fetal size are dealt with in the material that follows

Our original jacket, made of celluloid-impregnated stockinet stretched over a frame of aluminum tubing, was expensive to build and gradually pulled out of shape

these hernial openings is greatly facilitated by cutting the suspensory ligament and retracting the left lobe of the liver to the right. This can be accomplished, when the left lobe is small, by folding it on itself, and when it is large, by retracting it forward into the wound. The spleen is often very adherent to the posterior part of the diaphragm and hernial openings but usually can be separated from these structures by blunt dissection. It is retracted posteriorly by a properly constructed retractor. In some instances the spleen may be so traumatized by separating it from the hernial opening in the thoracic portion of the diaphragm that it is advisable to remove it. This occurred in two cases of this series.

Hernia through the Esophageal Hiatus — Because para-esophageal hernia is the most common type seen in adults, this is the only special type of hernia in which the details of surgical treatment will be given here. These hernias through the esophageal hiatus have a hernial sac. The attachment of the sac to the stomach must be separated and the sac either completely removed or permitted to retract into the posterior mediastinum. This is one of the most important technical considerations in the surgical treatment of these hernias.

After the sac has been removed, the enlarged esophageal hiatus is repaired by overlapping the margins of the opening. Closure is usually made to the left of the esophagus, but in some cases it is necessary to close, partially, both to the right and left of the esophagus. In a few instances the enlargement of the esophageal opening is posterior, extending to the spinal column and requiring the overlapping of the margins posterior to the esophagus. In such cases the condition is often thought to be a herniation through the aortic opening, but usually extending over the aorta there is an imperfectly developed fibrous band which is the margin of the defective esophageal hiatus. The closure is usually made with living sutures of fascia lata which are removed from the thigh. The overlapped margins of the hernial opening are first stabilized with interrupted linen sutures.

The fascia lata is then woven into the tissues by continuous suture and fixed in the tissues with interrupted linen sutures.

Before closure of the defective esophageal hiatus is completed around the lower part of the esophagus it is important that a stomach tube of large caliber be placed through the esophagus into the stomach to aid in the reconstruction of the normal esophageal opening and to prevent constriction of the esophagus by a tight closure. A small portion of the esophageal wall is incorporated in the innermost margin of the closure by a suture of chromic catgut.

Not uncommonly in these cases there is an associated traumatic erosion in the herniated portion of the stomach, along the lesser curvature, close to the cardia, and this erosion is often adherent to the margins of the hernial opening. Great care should be used in replacing the stomach in the abdomen and in removing the sac from the stomach because of the danger of perforating this thinned-out portion. In cases in which the ulcerated portion is penetrated, it should be repaired immediately with continuous catgut and linen sutures. Perforation occurred in two cases of this series, and the perforated portion was immediately repaired and the patients had an uneventful convalescence.

The abdomen should always be thoroughly explored for any other lesion, particularly of the stomach or gall bladder. In some cases it may be necessary to operate on other associated lesions, as occurred in two of this series. In one of these cases it was necessary to perform gastric resection because of a perforating ulcer high on the lesser curvature, which was probably secondary to a traumatic erosion, in the second case the patient had a large, obstructing duodenal ulcer for which it was necessary to perform gastro-enterostomy. It is inadvisable to carry out any additional surgical procedure at the time of repairing the hernia unless it is imperative, but it is well to know if the patient has gallstones or any other lesion in the upper part of the abdomen which might account for subsequent symptoms.

he is setting up an instrument designed to meet the conditions of his particular laboratory, but once this has been done he can

other workers. It is important merely that the values be known and that in the instrument used for working up films they

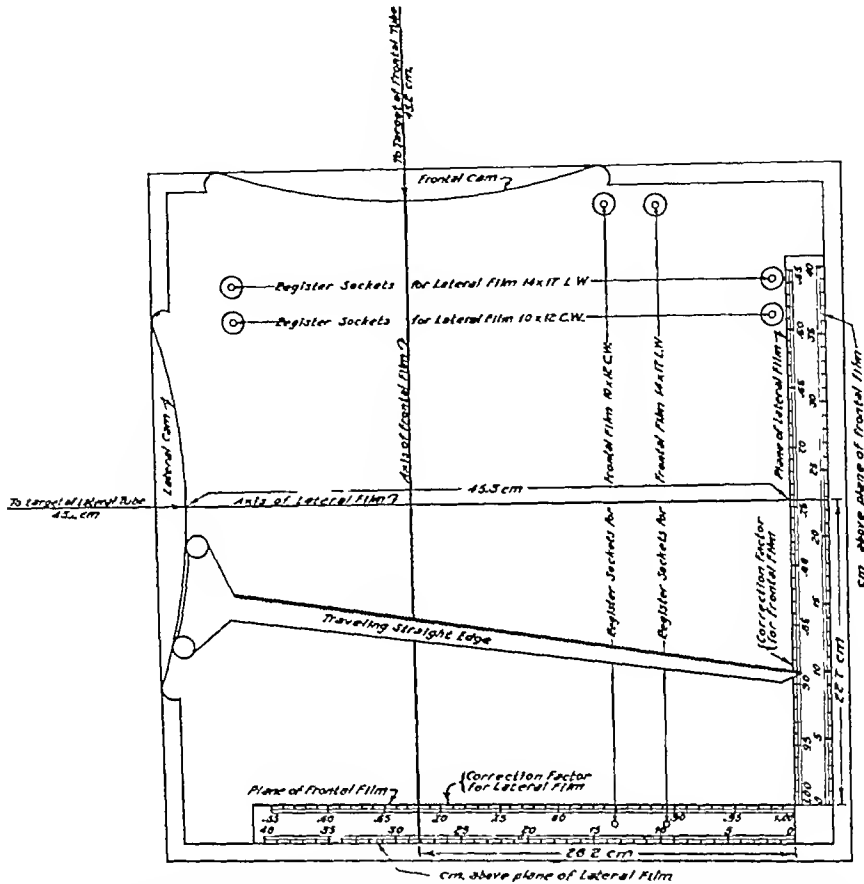


Fig 3 Top view of travelling straight-edge instrument for working up 90° triangulation films made by the jacket method. The working surface of the instrument is cork linoleum. The cams, film studs, register sockets and scale are of brass. The travelling straight edge of aluminum. The correction factor is computed from Equation 1 (1). The distances between axes and planes of films and targets and planes of films are the same as those obtaining in our apparatus for the filming of pregnant women. Values can be varied to suit the needs of other workers.

devote himself entirely to the clinical aspect of the work, leaving to any reasonably intelligent stenographer or technician the routine working-up of films

In the jacket method as employed by us at present, target-film distance (d) is 88.5 cm, the axis of the frontal film is displaced 28.2 cm from the plane of the lateral film, and the axis of the lateral film 22.7 cm from the plane of the frontal film. These values and certain others such as the distances between register points and optic axes can be changed to suit the needs of

be the same as those obtaining at the time
the films were made

In the completed roentgenograms one punches register holes, identifies and marks the frontal film and the lateral film, locates by inspection the approximate centers of the shadows of the fetal skull, and marks these centers by pin pricks. For the living subject, films will usually be size 14×17 in., placed lengthwise, or for heavy women they may be placed crosswise. In experimental work, smaller films may be used with their axes in either direction. Figure

tant factor in making a definite diagnosis. It is also of great aid in determining the size and situation of the opening and the type of abdominal viscera which has herniated. The symptoms are usually progressive and vary in type and intensity, depending on the amount and type of herniated abdominal viscera and the degree of mechanical interference with the normal function of the diaphragm, heart, and lungs. The symptoms often resemble those of other organic diseases of the abdomen and thorax, especially cholecystitis, peptic ulcer, cardiac disease, secondary anemia, and esophageal obstruction. Operative replacement of the herniated viscera and repair of the abnormal opening in the diaphragm is the only treatment that

insures complete relief of symptoms. The hernial opening is best repaired through an abdominal approach, by using fascia lata and interrupted linen sutures. Temporary or permanent interruption of the phrenic nerve is of value as a preliminary procedure to radical closure of large openings, particularly when there is deficiency or loss of structure of the diaphragm.

The surgical procedures and results in 131 cases have been reported. Radical repair of the hernia was carried out in 120 cases. There were seven operative deaths. Of the 113 patients who recovered from radical operative repair of the hernia, 110 were relieved of symptoms. In the remaining three cases the hernia and symptoms recurred.

soning it follows that the actual position of the center of the skull in space relative to the x-ray tube and films must be the crossing of these two dotted lines ²

From this point of crossing, new perpendiculars are dropped, one horizontally to the right to the plane of the lateral film, the other downward to the plane of the frontal film. This done, we may read at the foot-points of these secondary perpendiculars the height of the center of the skull above the plane of the frontal film (in case illustrated, 18 cm) and above the plane of the lateral film (in case illustrated, 24.5 cm). Knowing the value of these (d's) and knowing further that the D is fixed (88.5 cm), we may, if we wish, turn to a graph of Equation I (1) and thus obtain the correction factors for both films. It is simpler, however, to have these factors engraved on the rule of the instrument so that instead of reading the height of the skull center above the films, one reads off the correction factors directly. Note that the factor for the frontal film is obtained from measurements in the plane of the lateral and the factor for the lateral film from measurements in the plane of the frontal.

As yet our principal use of the jacket method has been in experimental work with dead fetuses, but we have put it to some clinical use with fair success. The principal difficulty recognized at present is the fact that in the lateral view the fetus is sometimes excessively far from the film

TEST OF VALIDITY OF MEAN CIRCUMFERENCE AS AN INDICATION OF FETAL AGE

Through the co-operation of Dr. Fred Adair and Dr. Edith L. Potter we have been able to examine a considerable number of the dead fetuses that are brought in from all over the city to be autopsied at the Chicago Lying-in Hospital. For this work we set up in a room adjacent to the autopsy room apparatus consisting of wooden supports for a lateral film and lat-

eral tube, frontal film and frontal tube arranged with film axes, film planes and tube targets in the same relationship as in our travelling straight-edge instrument and in our clinical filming apparatus.

As a preliminary step, OFD was measured roentgenographically by a precise "position" technic which we shall not describe in detail at this time. Following this, the fetal cadaver was placed on a masonite supporting platform above the frontal film and in front of the lateral film. It was arranged that the distances from the skull center to the two films should be approximately the same as those obtaining in our raying of living objects, but we purposely avoided measuring these distances and did not arrange the skull for any particular angular relationship between the plane of its occipitofrontal axis and the plane of the film. Care was taken, however, to assure that the skull was not moved during the making of the two films. At the autopsy which followed, Dr. Potter cutting through the scalp at the frontal and occipital poles made direct caliper measurements of occipitofrontal diameter (OFD). In numerous cases the films obtained were not suitable for measurement because of skull defects or disease (all of the fetuses were stillborn) or because of technical difficulties occurring early in the experiment, but in 15 of the cases measurements could be made. These 15 cases were worked up on the travelling straight-edge instrument to obtain correction factors, and from the average corrected circumferences age was computed (1). Age was also computed from OFD (1). Under the conditions of this experiment our measurements of OFD may be accepted as extremely accurate, and so, except for the unavoidable factor of biological variation, the estimates of age based on the OFD are accurate. In Table I, column 6 shows the average corrected circumference of each skull, column 3 shows the probable age in weeks computed from the OFD, and column 4 the probable age computed from circumference. Column 5 shows the percentage of error in the estimate of age from circumference, assum-

² Actually these lines represent the edges of planes and the point of their crossing represents the end of the line but for our purposes the third dimension may be ignored, with resulting simplification of explanation.

sagittal plane of the body Laid off on a graph of Equation 1 (1) it supplies a correction factor for reducing distorted or gross anteroposterior diameter to net anteroposterior diameter

(C) *A Single Film or Stereoroentgenograms Showing the Inlet (Position III)* — This view is superior to all others for qualitative study of the inlet as a whole and for measurement of its transverse diameter If but a single film is used, the distance from inlet to film (d) must be measured at the time the examination is done For such a single film or for stereoroentgenograms the work-up is the same as in case B, described above

Some workers deliberately defer all examination until the closing weeks of pregnancy so that the study of the pelvis may be combined with that of the fetus On the other hand, though the referring obstetrician may concur as to the desirability of early examination, exigencies may prevent this and require that one attempt pelvic measurements from films made late in pregnancy The principal disadvantage lies in the fact that Position III, so essential to adequate study and measurement of the inlet, involves raying through the entire length of the enlarged uterus with resulting excessive scattering of radiation and blurring of film images

EXAMINATION OF THE FETUS

The two or four fetal films that are regularly made late in pregnancy are distributed as follows

(D) Two pairs of stereoroentgenograms, one pair in the frontal position (Position I), the other in the lateral position (Position II),

or

(E) One pair of 90° triangulation films, one in the frontal position (Position I), the other in the lateral position (Position II)

With either type of filming one proceeds first to the non-quantitative studies of the sort tabulated in the opening paragraphs of this paper, after which he measures

various parts of the fetus and attempts to estimate its age Usually such estimates are simply of academic interest, but they may assume clinical importance when the menstrual history is in doubt or the possibility of a dead fetus is being considered

ESTIMATION OF FETAL AGE FROM OFD OR BPD

Theoretically it should be possible to measure occipitofrontal diameter with the aid of the measuring stereoscope or the stereoroentgenometer in every instance, regardless of the angular relationship between fetal skull and film Practically such measurements are reliable only when the occipitofrontal axis lies in a plane approximately parallel with the plane of the film (Figs 5-a, 5-c, and 5-d) The difficulty has nothing to do with the theory of stereoscopic triangulation, depending instead upon the fact that the so-called "end-points" of the occipitofrontal diameter do not constitute actual bony protuberances but are merely locations on the surfaces of flat bones

When the occipitofrontal axis lies in a plane parallel with the plane of the film, the anterior and posterior poles of the skull appear as sharply silhouetted arcs If there is any great degree of obliquity between axis and film, however, these poles do not appear in silhouette and identification of the end-points of the axis becomes difficult if not impossible (Figs 5-b and 5-e) The situation is the same in the case of biparietal diameter, which dimension can be measured accurately only when the biparietal axis lies in a plane approximately parallel with the plane of the film

It has been suggested by others (but not yet attempted by us) that when a preliminary examination demonstrates an oblique lie of both occipitofrontal and biparietal axes, an additional examination might be done after manipulation of the fetus or rotation of the mother under fluoroscopic control until one of these axes lies in a plane parallel with the plane of the film

ing the values computed from OFD to be correct

LIMITATIONS OF CIRCUMFERENCE AS A GUIDE TO SIZE OF SKULL AND AGE OF FETUS

In two-thirds of the 15 cases presented in Table I, the age predicted by circumference was correct or too great. In one-third of the cases it was too small. Numerous technical factors presumably combined to cause the smaller + and - errors but almost certainly the largest + error (11 per cent) was produced by lack of parallelism between the plane of the occipitofrontal axis of the skull and the plane of radiation common to the two x-ray tubes.³

The scope and limitations of roentgenographic measurements of occipitofrontal diameter, biparietal diameter and circumference as indicators of skull size are illustrated in Figure 5. In 5-a and 5-c all three measurements are valid. In Figure 5-b conditions are satisfactory for measurements of circumference but not for occipitofrontal diameter or biparietal diameter.

³ In our clinical apparatus only one tube is used and film and film are fixed for the two exposures but the patient turns between them. Under such conditions the surface of reference is a plane perpendicular to the plane of the long axis of the patient's body referred to for convenience as the transverse plane of the body.

In Figure 5-d measurements of occipitofrontal diameter and biparietal diameter are dependable but circumference is not. In Figure 5-e all three measurements fail.

To recapitulate

(1) Occipitofrontal diameter can be measured only when the occipitofrontal axis of the fetal skull lies in a plane approximately parallel with the plane of the film. Obliquity of the axis relative to the film foreshortens the measurement and thus predicts too small an age.

(2) Biparietal diameter can be measured only when the biparietal axis lies in a plane approximately parallel with the plane of the film. As in the case of the occipitofrontal diameter, obliquity of the biparietal axis relative to the plane of the film foreshortens the measurement and thus predicts too small an age.

(3) The circumference of the skull of a fetus *in utero* (that is, the average net circumference taken from two films made at right-angles to one another) may be used in connection with graph No. 21 (1) of Equation 17A (1) for estimation of fetal age only when the occipitofrontal axis lies in a plane approximately parallel with the transverse plane of the body of the mother. Obliquity of the occipitofrontal axis rela-

Fig. 5 Effect of obliquity of skull upon roentgenographic measurements of circumference, occipitofrontal diameter and biparietal diameter.

a Vertex down, right parietal region looking forward in the frontal view. The occipitofrontal axis (shown as a solid line) lies in a plane parallel with the transverse plane of the body and parallel with the frontal film. The biparietal axis (shown as a dotted line) lies in a plane parallel with the plane of the lateral film. Under these circumstances all three measurements can be made: occipitofrontal diameter in the frontal film, biparietal diameter in the lateral film, and circumference from the combination of the two.

b Vertex down, right parietal region looking obliquely forward and to the right in the frontal view. This causes both axes to be oblique to the film in both frontal and lateral views and accordingly makes them unsatisfactory for measurement. The occipitofrontal axis remains parallel with the transverse plane of the body, however, and so the mean of the circumferences as measured in frontal and lateral films can be used for estimating the age of the fetus.

c Vertex down, left parietal region looking forward and downward in the frontal view. Occipitofrontal axis parallel with the transverse plane of the body. Skull rotated slightly about the occipitofrontal axis so that the vertex looks slightly backward. In the frontal view occipitofrontal diameter can be measured, in the lateral view, biparietal diameter from the combination of the two circumferences.

d Fetal head flexed sharply on neck so that vertex looks directly forward in the frontal view. In both frontal and lateral views occipitofrontal axis is parallel with the plane of the film and in the frontal view the biparietal axis is parallel. This means that biparietal diameter can be measured in the frontal film and occipitofrontal diameter in either of them. The occipitofrontal axis is not parallel with the transverse plane of the body, instead it is rotated as far as possible out of this parallel relationship or in other words stands at 90° to the transverse plane. As a result of this circumference cannot be used as a guide to fetal age.

e In the frontal view vertex directed downward, forward, and to the left. Left parietal region directed forward upward and to the left. In skew positions of this sort where the occipitofrontal and biparietal axes are not parallel with the film in either view and where the occipitofrontal axis is not parallel with the transverse plane of the body, no one of these three criteria of fetal age can be employed with accuracy. In the case of circumference the difficulty is fundamental in the theory involved while in the case of the two axes it depends upon the fact that such positions fail to throw the end points of the axes into silhouette, a condition essential to their accurate identification.

The present jacket (Fig 1), made of sheet bakelite riveted to a frame of welded square steel tubing, is provided with cross-

of the stereoroentgenometer for other purposes (Figs 2, 3, 4) By means of this instrument computations of all sorts are

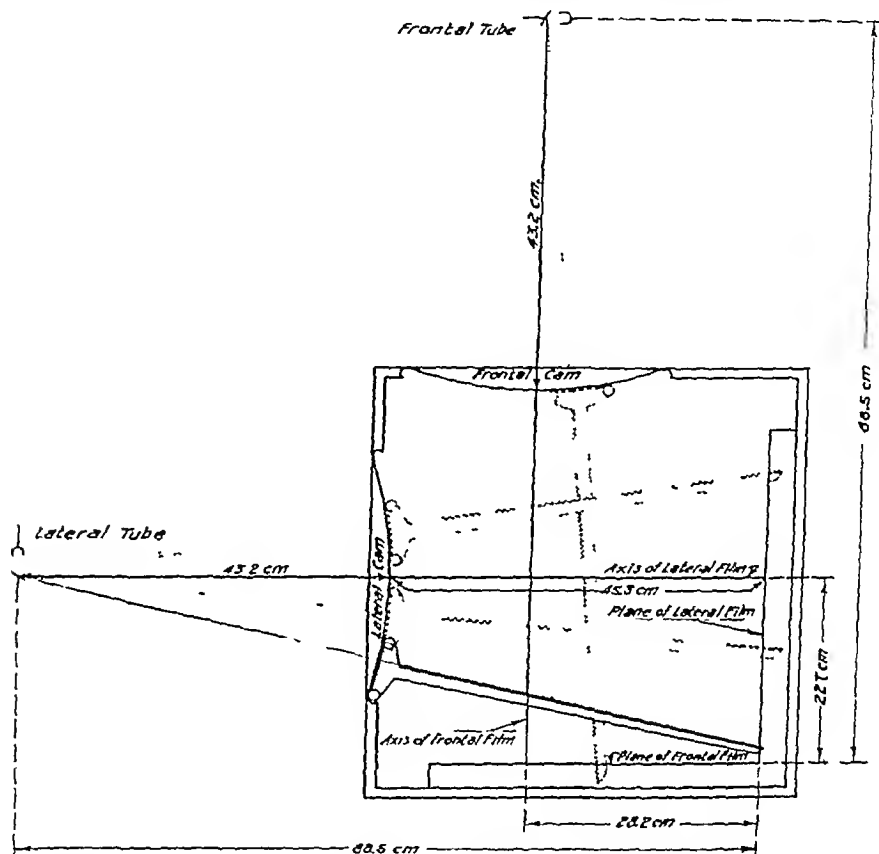


Fig 2 Straight edge travelling on cam to indicate direction of radiation Where space is available one needs merely a large drawing board with threads attached to two pins representing the targets of the two tubes and two metric rulers representing the planes of the two films Such an apparatus is in effect McKenzie Davidson's cross thread apparatus designed for two-dimension rather than three dimension construction It is clumsy to use threads pivoted 88.5 cm. out in space and more convenient to use cams curved and located so that straight edges moving along their surfaces correspond to threads stretched from pivots 88.5 cm. distant

braces that are easily inserted after the patient is in place These prevent bending of the sides of the jacket as the binder is tightened

TRAVELLING STRAIGHT-EDGE INSTRUMENT FOR WORKING UP 90° TRIANGULATION FILMS

For the work-up of 90° triangulation films we no longer employ plotting charts but instead an instrument composed of travelling straight edges and scales which, for economy of office space, has been incorporated with the bed of our stereoroentgenometer without interfering with the use

eliminated and one obtains by graphic means alone correction factors for skull circumferences and diameters in both films Like all detailed descriptions of geometric instruments, a description of this one will at first seem rather complicated Anyone who has studied high school geometry and algebra will find, however, that both the instrument and its application are quite simple once the newness has worn off It must be admitted that the average roentgenologist will probably need the assistance of a machinist, physicist, engineer, or mathematician while

THE USE OF INTERSTITIAL RADIATION IN THE TREATMENT OF PRIMARY AND RECURRENT CARCINOMA OF THE UTERINE CERVIX¹

By A N ARNESON, M D , *St Louis, Missouri*

From the Edward Mallinckrodt Institute of Radiology and the Department of Obstetrics and Gynecology, Washington University School of Medicine

IN many clinics there is a tendency to standardize the treatment of cervical cancer so that a routine method of radiation is used for all patients. No single method is suitable for all individuals, but in most instances there are certain advantages to be gained if treatment is begun with external radiation (8). By that means the amount of infection in the lesion can be reduced, which, in turn, will lessen the local reaction from radium applied at a later date. A preliminary course of x-rays also facilitates radium treatment by producing some regression in the size of the primary lesion. However, if the percentage of cures is to be increased materially, it is essential to individualize both the roentgen and radium treatment of each patient to meet the requirements of the lesion in question, rather than to apply a single method to all patients with cervical cancer.

In a previous publication (2) diagrams illustrating the distribution of roentgen radiation within the average female pelvis were given for different physical factors of radiation. In the treatment of carcinoma of the cervix it is essential that a large dose be given to the parametrium without over-radiating normal structures in other regions. A six-field technic (two on the anterior surface, two on the posterior, and one on each lateral aspect of the pelvis) was found to deliver the greatest amount of radiation to the parametrium without too great a percentage of the total dose falling upon the bladder and rectum. That arrangement of skin portals is suited to most patients with cervical cancer, but in every instance the attempt should be made to individualize the treatment. A different

technic might be more practical for patients presenting a marked degree of involvement anterior or posterior to the cervix.

There is general agreement that an intra-uterine tandem containing radium will not control disease located at distances greater than 3 or 4 cm from the cervical canal. In the attempt to increase the radius of effect from radium applied to the primary lesion, Healy (6) and others have devised various intra-vaginal applicators for use in conjunction with an intra-uterine tandem. In most patients, however, radium alone is inadequate for delivering a lethal dose to the entire tumor-bearing region. External radiation is essential in the attempt to treat adequately the disease located in outlying tumor-bearing areas, and in the deep lymphatics.

The distribution of radiation for different methods of applying radium to the cervix has been shown diagrammatically by Lucas (10) and the author (1). While these diagrams show that radium alone is inadequate for most patients, they also illustrate the fact that a greater number of sources of radium distributed more widely throughout the uterus and vagina will, for specified doses, increase the *minimum* amount of radiation reaching the tumor, and decrease the risk of over-radiating some regions. It is obvious that normal structures must be protected from doses that will result in permanent damage, but it should be noted also that the *minimum dose* is even more important than the *maximum amount* of radiation delivered to a given volume of tissue. If the dose reaching some parts of the tumor is less than the amount required for producing a lethal effect upon the disease, that portion of the tumor will recover from the tempo-

¹ Presented before the Fifth International Congress of Radiology, at Chicago Sept 13-17, 1937

from infection resulting from the introduction of needles, and evidently local reactions were not beyond the limits of repair

sued to treatment with interstitial radiation. Control of the disease usually requires relatively large amounts of radia-



Fig 1 Location of an intra uterine tandem composed of three capsules containing 25 mg radium each with a filter equivalent to 0.5 mm Au and steel needles of 12.5 mg strength used in the palliative treatment of a patient with a recurrent lesion involving the cervix and vaginal vault, and an isolated metastatic nodule in the left wall of the vagina. The curved and lighter shadow is formed by rubber tubing around the intra uterine sources.

Their excellent statistics show clearly that interstitial radiation is of value in the treatment of cervical cancer. They concluded that the method was particularly valuable in the treatment of Stage III (Schmitz) cases, which, of course, represent patients with disease located at distances beyond the radius of effect of radium inserted into the cervical canal and uterine cavity.

During 1936 we began to use interstitial radiation in some patients with cervical cancer. For the earliest treatments we selected those with recurrent lesions. They were chosen for two reasons: in the first place, the method was, in our hands, an experimental procedure, and it was believed essential to proceed by a process of trial and error on patients with a poor prognosis in the attempt to determine the amounts of radiation the regions involved would tolerate. In the second place recurrent lesions were for various reasons

tion, because the character and radiosensitivity of the tumor have been altered materially by the earlier treatment. At the same time care must be exercised in administering additional amounts of radiation, because of the risk of causing the previously radiated tissues to break down with necrosis and slough. The dose delivered to the diseased area by means of external radiation is usually inadequate for producing any permanent change in the tumor, and in many instances that method may not be practical due to the condition of the skin in the fields used previously. Radium applied to the uterus, or in the vagina, if used in amounts considered adequate for controlling the disease within a radius of 3.0 or 4.0 cm, is apt to over-radiate the tissues nearest to the application and produce a persistent ulcer. Interstitial radiation presents a means of at least partially overcoming some of the above-mentioned difficulties. The more uniform distribu-

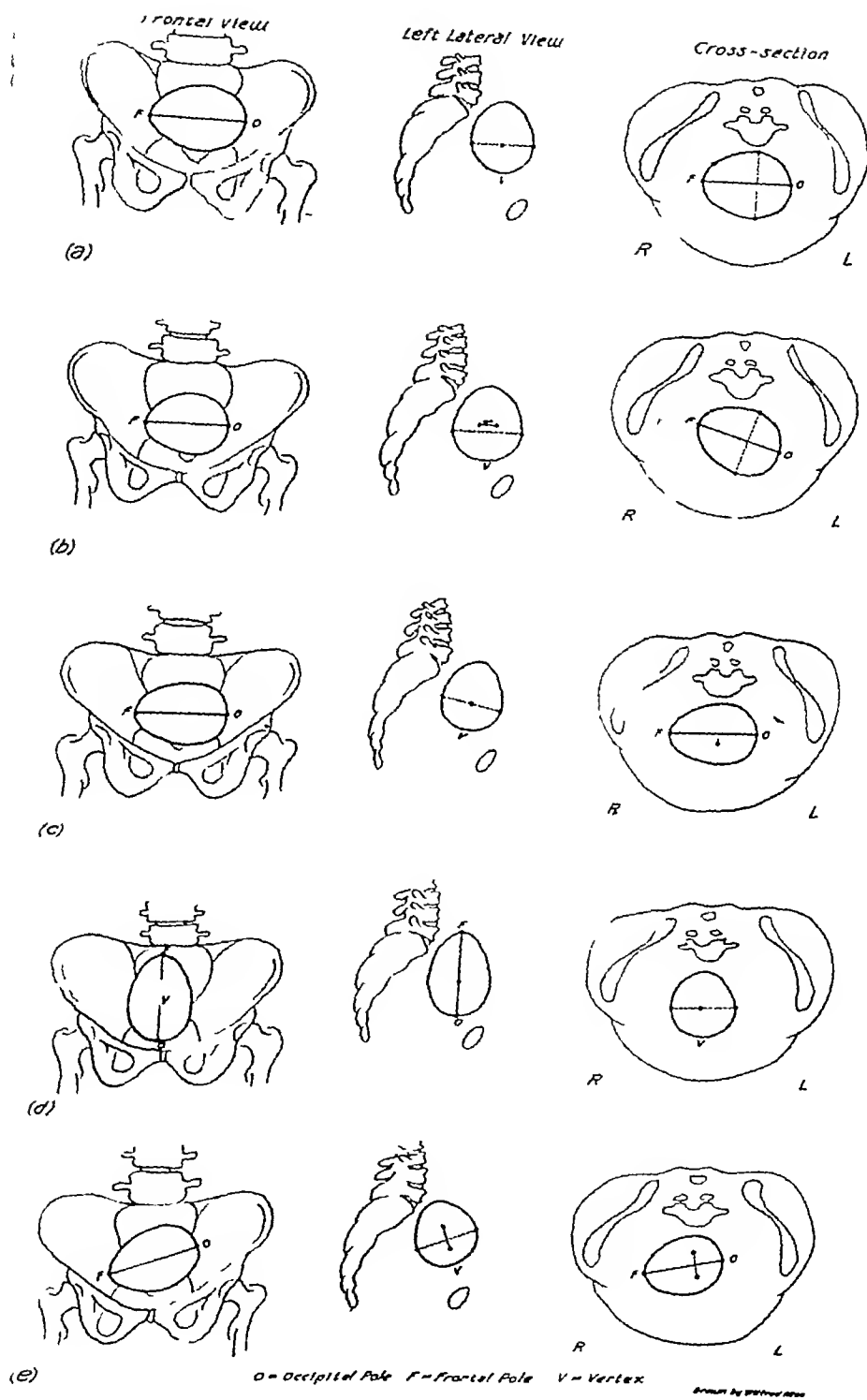


Fig 5 (See facing page for explanation of plate)

lesion Due to metastases present in the lungs and supraclavicular nodes that had not responded satisfactorily to external radiation, the additional radium was given only as a palliative measure in the attempt to control bleeding from ulcerations on the cervix, vaginal vault, and on the left lateral wall of the vagina For that purpose a minimum of four or five threshold doses was considered adequate Treatment was administered by means of six steel needles (12.5 mg radium each) inserted into the cervix and left vaginal fornix around an intra-uterine tandem composed of three capsules containing 25 mg each As can be seen in the radiograph, the sources were relatively far apart Two additional needles of the same strength were inserted into the separate vaginal nodules For the specified arrangement of radium in the cervical region, and the volume of tissue to be treated, approximately 2,000 mg-hr were required for delivering the predetermined minimum of four or five threshold doses There was only a mild reaction, and the treatment was adequate for promoting healing of the ulcerated areas, which controlled the bleeding until the patient's death a few months later resulting from the distant metastasis present before radium was applied

In spite of the inadequate filter and relatively large radium content of the needles described above, they have been used for greater doses in some instances For example, in Figure 2 is shown a radiograph illustrating their use in the primary treatment of a patient presenting a particular problem The disease was very extensive, and a huge, badly infected and ulcerated crater replaced completely the cervix, vaginal vault, and the lower portion of the uterus It was possible to see directly the entire uterine cavity, which was only 3.0 cm deep There was also a vesico-uterine fistula After a preliminary course of external irradiation² it was decided that

² A short course of roentgen treatment was employed instead of a prolonged series of divided doses Due to the risk of pelvic peritonitis and other complications, we have abandoned the longer method in patients with very extensive and badly infected lesions

radium should be given in two applications so that the dose from any needle at any given time would not exceed 150 mg-hr At each application approximately 2,000 mg-hr were administered by means of three 25 mg capsules arranged in a triangle and packed into the shallow uterine cavity, and eight 12.5 mg needles inserted in a radial fashion within the inner half of the radius of the crater The treatments were given two weeks apart

From both x-rays and radium the central pelvis received a minimum of from six to eight threshold doses The outlying tumor-bearing regions received a minimum of about three or four threshold doses The latter amount will rarely produce a lethal effect upon cervical cancer, but a fairly large volume of the more centrally located disease was radiated adequately, as evidenced by regression in that region It is doubtful if radium placed only in the uterine cavity and vagina could have been used safely for delivering an equal minimum dose to the same volume of tissue However, the patient presented a hopeless prognosis She died some time later with uremia due to obstruction of both ureters

Sheath needles for removable platinum cells containing different amounts of radium have been found to be more satisfactory than the above-mentioned sources This is not only the result of the heavier filter and the lower intensity of radiation, but also due to the variety of changes that can be made in the length and strength of sources In Fig 3 is shown a radiograph illustrating their use in a patient with a hard nodular recurrence in the left parametrium which had extended along the anterior vaginal wall and infiltrated the base of the bladder Treatment was administered in the attempt to relieve the bladder distress, but it was feared that the dense avascular tissue might break down For that reason a method of treatment was planned that would deliver a minimum of three threshold doses, without amounts greatly in excess of that arriving at points more than 0.5 cm from any particular implant The predetermined dose was ad-

TABLE I—TEST OF VALIDITY OF MEAN CIRCUMFERENCE AS AN INDICATION OF AGE

Material	Occipitofrontal Diameter		Age		Percentage Error of Estimate from Circumference	Circumference
	Caliper	X-ray	From OFD	From Circum		
A-1	6 4	6 4	21 ¹ / ₄	22	+ 1 15	17 6
A-2	11 5	11 5	37	36 ¹ / ₄	- 2 00	30 25
A-3	10 9	10 85	35 ¹ / ₄	36	+ 2 13	30 24
B-1 } Twins	6 5	6 8	22 ³ / ₄	23 ¹ / ₂	+ 3 30	19 23
B-2 }	7 1	7 3	24	25	+ 4 20	20 46
B-3	10 3	10 46	33 ³ / ₄	33 ¹ / ₄	- 0 70	28 1
B-4	11 0	11 2	35 ³ / ₄	39	+11 00	32 24
B-5	9 7	9 6	31 ¹ / ₄	32 ¹ / ₄	+ 3 15	27 16
C-1 } Twins	6 4	6 3	21 ¹ / ₂	21 ¹ / ₄	+ 2 32	17 24
C-2 }	6 6	6 6	22 ¹ / ₄	22 ¹ / ₂	+ 1 12	18 0
C-3	6 0	6 1	21	20	- 4 76	15 28
C-4	9 3	9 3	30	28 ¹ / ₂	- 5 00	23 9
C-5 } Twins	7 5	7 1	23 ¹ / ₂	23 ¹ / ₂	0	19 25
C-6 }	7 1	7 0	23 ¹ / ₄	24	+ 3 22	19 54
C-7	9 8	9 6	31	29 ² / ₄	- 4 00	24 8
Column Number	1	2	3	4	5	6

tive to the transverse plane of the body increases the value of the average circumference and thus predicts too great an age. In the extreme case where the axis lies 90° to the transverse plane, frontal circumference and lateral circumference are equal and the predicted age is much too great.

One who attempts to determine the age of a fetus *in utero* from measurements of the roentgenograms must exercise judgment. In those cases in which conditions for measurement are good, age estimates should be given out with confidence and looked upon as accurate within the limitation of biological variation (in the majority of cases, + or - two weeks). When a preliminary study of roentgenograms shows an occipitofrontal axis slightly oblique to the plane of the film and to the transverse plane of the body, errors in prediction are inevitable. If circumstances make it necessary that a prediction be attempted, the difficulties of measurement should be described in the report and it should be recognized that if age is being predicted from occipitofrontal diameter the prediction is probably too small, if from circumference, probably too large. In certain skew positions of the skull one must recognize that he cannot employ circumference as a guide to age.

Skewness of any type or degree might be present without interfering with measurement of occipitofrontal diameter or biparietal diameter by means of the measuring stereoscope or the stereoroentgenometer if the end-points of the axis could be located accurately. In most cases, however, the end-points cannot be identified with accuracy unless the plane of the axis is approximately parallel with the plane of the film.

SUMMARY

- (1) An improved jacket for the making of 90° triangulation films and an instrument for working up such films are described.
- (2) The usefulness of skull circumference as a guide to fetal age is demonstrated by experiments on 15 fetal cadavers.
- (3) The limitations of occipitofrontal diameter and biparietal diameter as indicators of fetal age are discussed.
- (4) It is pointed out that like these other two measurements skull circumference has its limitations as a guide to fetal age.

REFERENCE

- (1) HODGES, PAUL C. Roentgen Pelvimetry and Fetometry. *Am Jour Roentgenol and Rad Ther*, May 1937, 37, 5.

careless and irregular arrangement of interstitial sources used in the treatment of a patient with a large mass in the right parametrium

believed that an intra-uterine tandem and x-rays should be adequate for controlling the disease in that region. However, a method other than the placing of radium



Fig 4 An irregular arrangement of interstitial sources used in the primary treatment of a patient with a large mass in the right parametrium. The shorter needles, 20 mg radium each, have an active length of approximately 20 cm. The two longer needles are approximately 60 cm in length and contain 55 mc radon. The intra uterine tandem is composed of three capsules containing 25 mg radium each. All sources have a filter equivalent to 0.5 mm Au.

This patient had a small, non-ulcerated primary lesion which had not caused any enlargement of the cervix. There was no clinical evidence of involvement in the left parametrium, but there was a large, irregular mass at least 5.0 cm in diameter on the right side that bulged into the vaginal fornix and held the uterus in a fixed position. There was little evidence of regression following the administration of from two to three threshold doses throughout the pelvis by means of external irradiation. Radium was applied two weeks after the completion of x-rays, and it was deemed necessary to deliver an amount that would bring the minimum tissue dose to at least six to eight threshold doses. Since there was no clinical evidence of involvement in the left parametrium, it was

in the uterus or vagina was necessary for delivering the predetermined minimum dose to the right side. Treatment was administered by means of 10 needles of 20 mg strength with an active length of 20 cm and two needles 60 cm long containing 55 mc radon each. The interstitial sources were used for a period of five days and delivered equivalent of 3,300 mg-hr. An intra-uterine tandem was used for 3,000 mg-hr. The total radium dose was, therefore, 6,300 mg-hr. For the arrangement of sources and the volume of tissue treated, that amount of radiation combined with x-rays represented a minimum of from six to eight threshold doses. The mass on the right side regressed completely with the exception of a small region near its upper border. The persistent disease was prob-

rary effect of the treatment and then continue to grow. A greater percentage of the volume of tissue in question will receive an adequate amount if the minimum dose delivered throughout that volume is increased.

The most logical means of distributing a greater number of sources of radium more widely throughout the tumor-bearing area is by means of interstitial radiation, such as needles, seeds, etc. For a number of years Ward (14) has combined needles with an intra-uterine tandem in the primary treatment of cervix cancer. The needles were usually inserted into the cervix in a radial fashion around the tandem. Healy (7) has implanted gold radon seeds into some patients with recurrent or persistent disease in the cervix and adjacent areas. Gellhorn (5) has reported the use of gold seeds in the parametrial regions. Taussig (13) performs lymphadenectomy after radiation, or implants seeds into the nodes or into regions occupied by the various lymph glands.

Other authors both here and abroad have reported the use of interstitial radiation, but for the most part gynecologists in this country have been reluctant to employ such methods. This has been at least partially due to the fear of introducing infection into the tumor by the insertion of needles and seeds, and to the fear of excessive reactions following such treatment. However, those complications were not found to be frequent sequelæ in the large series of patients with cervical cancer reported recently by Pitts and Waterman (11). Their statistics covered two periods of five years each. During the first period treatment was given at relatively high intensities by means of radium placed in the uterus and in the vagina (in many patients relatively strong steel needles were also used interstitially in the cervix). Total doses ranged from 3,000 to 4,000 mg-hr. These were administered in two or three applications made from two to three weeks apart. In 1926, which marked the beginning of the second five-year period of their published statistics, treatment was

given at lower intensities over longer periods of time (for a single application) by means of weak interstitial sources in both the cervix and parametrial regions. They used platinum needles containing relatively small amounts of radium (20 to 40 mg), with active lengths ranging from 30 to 45 mm.

When they first began to use interstitial sources routinely, the needles were inserted into the cervix, paracervical tissues, and parametrium, by introducing them through the vagina, and intraperitoneally through an abdominal incision. They later abandoned the intra-abdominal route. The general plan of their treatment was to place two needles (each containing 30 mg radium) into the parametrium along the right side of the uterus, and two similar needles into the left side. A total of from 12 to 16 needles (20 mg each) were inserted into the anterior and posterior lips of the cervix and para-cervical tissues. A tandem, usually containing 20 mg, was placed in the uterus. The radium was left in place for periods ranging from 72 to 96 hours, but during the last two years of their published statistics the time of radiation was from 144 to 168 hours. This indicates that some patients received approximately 10,000 mg-hr of irradiation over a period of seven days.

For the second five-year period (during which needles were employed), the authors report an absolute five-year survival of 31.7 per cent, as compared with 20 per cent for their older method. Furthermore, analysis of their statistics showed an absolute five-year survival of 36.3 per cent for the longer time of irradiation (144 to 168 hours), as compared with 21.8 per cent for the shorter time (72 to 96 hours). The uncorrected mortality following the use of needles was 2.9 per cent, and the incidence of fistulæ was 6.3 per cent.

Their uncorrected mortality rate, which may be higher than that experienced in most clinics, seems justified in view of the fact that their statistics show so much improvement over those usually reported. The authors experienced little difficulty

then essential to devise a method of treatment which will deliver a distribution of radiation suited best to the volume of tissue

of less than three threshold doses was relatively ineffective, and suggested that interstitial radiation, whenever practical,

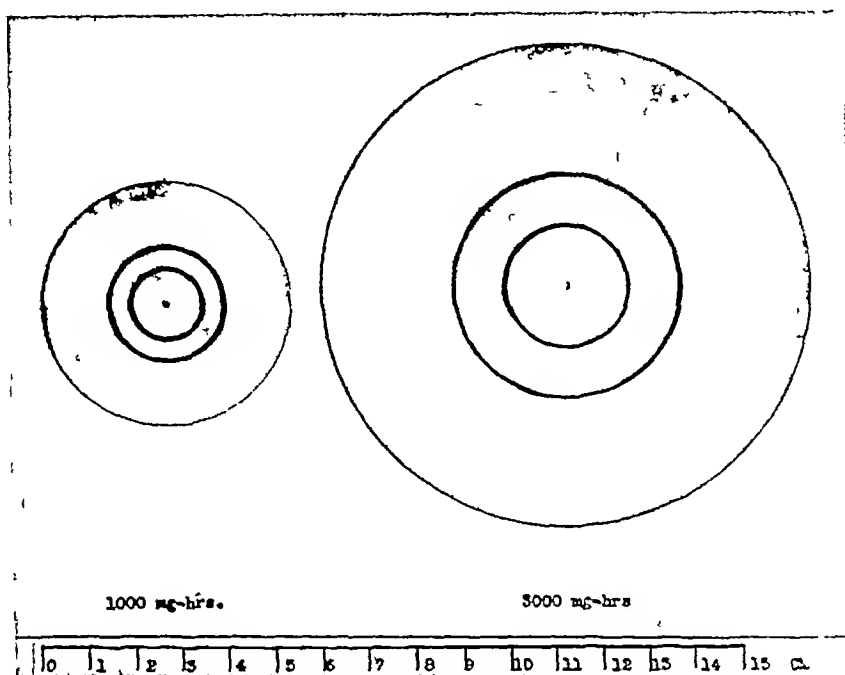


Fig 6 Isodose disks showing the distribution of one, four, and seven threshold doses from an average intra uterine tandem with 0.5 mm Au filter for 1,000 and 3,000 mg-hr radiation

to be irradiated. Finally, one must know how much radiation is necessary to deliver the predetermined tumor dose.

In general, greater tissue doses will be employed in the primary irradiation of a patient than in the treatment of a recurrent case, or one with very advanced disease in whom nothing more than palliation can be expected. There is evidence that, for specified methods of treatment, control of the disease in carcinoma of the cervix requires a *minimum* of from six to eight threshold doses (3, 9). The relation of five-year survivals to calculated tumor doses has been shown recently by Frazell (4). Relatively few patients were cured when some portions of the tumor received less than three threshold doses. The percentage of survivals was found to increase among patients who had received greater amounts of radiation. The author concluded that a method delivering a minimum

should present a method for increasing the quantity of radiation reaching the parametrial regions.

In the attempt to deliver a distribution of radiation suited best to the volume of tissue in question, it is essential that a number of different methods for applying radium be considered in planning the treatment of every patient. The addition of interstitial radiation to other procedures which may be employed increases the number of methods from which one may choose. In many patients, buried sources may present the most practical means of individualizing the treatment. Statistics presented by others illustrate the clinical value of interstitial radiation in the treatment of cervical cancer. The physical value of the method is evident from the fact that a number of weak sources are distributed throughout the tumor-bearing region. By that means it is possible to increase the *mini-*

rary effect of the treatment and then continue to grow. A greater percentage of the volume of tissue in question will receive an adequate amount if the minimum dose delivered throughout that volume is increased.

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delivered by the various needles for specified amounts of radiation are given in Table I

Similar isodose charts were also prepared for intra-uterine tandems. Due to the fact that radium applied within the uterus is usually employed for a relatively large amount of radiation it is practical to indicate upon each chart the distribution of one, four, and seven threshold doses. However, tandems frequently contain more radium than would justify their use for 133 hours. It was believed impractical to apply the same standardization of dose employed for needles. Instead of drawing isodose curves for 1 mc-destroyed per milligram strength, the charts were prepared for a specified number of milligram-hours' radiation. In order to provide some variation in dose, isodose disks were made for average intra-uterine tandems delivering 1,000 mg-hr, and 3,000 mg-hr as shown in Figure 6. The distances to which different threshold doses are delivered along a line perpendicular to the middle of the tandem for the specified amounts of radiation are shown in Table II. For pre-

The disks can be superimposed over a diagram illustrating a lesion to be treated, and the approximate tissue dose determined for any given arrangement of radium. If a source is used for double the dose, then two threshold doses will arrive at the circle indicating one, but for the greater number of milligram-hours one threshold dose will not arrive at twice the distance, but at a point which received 0.5 threshold dose.

Despite the fact that the curves were prepared from data published by Qumby, the standard dosage tables she has given cannot be dispensed with unless disks are prepared for each dose for which a given source may be used. A reasonable knowledge of the standard data is essential, but with a little practice it is possible to arrive at tissue doses from the disks that are in good agreement with those calculated from the tables.

The isodose curves have proven to be useful aids in teaching the principles of interstitial radiation. They present a fairly rapid method for determining the amounts of radiation required for delivering a predetermined tissue dose considered adequate for a given lesion. Furthermore, use of the disks necessitates a careful planning of radiation that insures individualization of treatment.

Interstitial radiation has been demonstrated to be of value in the treatment of both primary and recurrent carcinoma of the cervix. As stated before, objections to the use of buried sources have been based chiefly upon the fear of introducing infection, and of producing severe reactions. The use of preliminary external radiation is undoubtedly an important factor in diminishing the risk of infection (8). It seems likely that some of the severe reactions noted earlier by other gynecologists may have been due to the use of relatively strong and inadequately filtered needles (*i.e.*, short steel or monel metal needles with an active length of 3.0 cm or less, and containing 10.0 or more milligrams radium). The lower intensity from adequately filtered sources containing relatively small amounts of radium (for ex-

TABLE II —TANDEMS

Dose in mg-hr	Total mc- destroyed	Distance Threshold Doses Delivered (cm)		
		1 T D	4 T D	7 T D
1 000	7.5	2.6	1.2	0.8
3 000	22.5	5.2	2.4	1.8

Distances that one, four, and seven threshold doses are delivered along a line perpendicular to the middle of an average intra uterine tandem with 0.5 mm Au filter for 1,000 and 3,000 mg-hr radiation.

paring the disks data were taken from an earlier publication upon the distribution of radiation for different methods of applying radium to the cervix (1). Diagrams presented in the article referred to can be used, if drawn to actual size, in conjunction with the isodose disks here shown for determining tissue doses from various combinations of needles, intra uterine tandems, and intra-vaginal applications of radium for specified amounts of radiation.

tion of radiation from multiple buried sources lessens the discrepancy between the minimum and maximum dose arriving

Before any patient has been treated with interstitial sources a suitable tissue dose has first been determined. A plan has



Fig 2 Location of radium used in the primary treatment of a patient with a very advanced and cratered lesion. Three capsules containing 25 mg. each were arranged in a triangular fashion and packed into the shallow uterine cavity. Eight steel needles of 12.5 mg. strength were inserted in a radial fashion within the inner half of the radius of the crater.

throughout the diseased area. By that means it is possible to deliver a reasonable dose at points located a few centimeters deep without enormously greater amounts arriving at the surface of the cervix and vaginal vault, or in the uterine canal.

At first the treatment was applied to those with disease reappearing only in the cervix itself, because a recurrence of that type indicates inadequate primary radiation and, therefore, there should be a minimum of risk in administering additional amounts. The method was later extended to include patients with more extensive recurrences, and recently it has been employed in the primary treatment of some individuals. Sufficient time has not elapsed to permit a statistical report upon the results obtained. However, a description of the method is justified in view of the excellent response of many lesions

then been worked out for inserting the needles in a manner to deliver the most suitable distribution of the predetermined dose. Data for the arrangement of interstitial sources, and the number of milligram-hours of radium required for treatment have been taken from publications by Qumby (12) which give the amount of radiation required for delivering various threshold doses to specified volumes. It should be noted that some recurrent cases were deliberately undertreated, due to the fact that the additional radiation was given for palliative purposes only. In many instances it was deemed advisable to attempt no more than to relieve pain or promote the healing of an ulcerated area.

In Figure 1 is shown a radiograph illustrating the location of needles used in the treatment of a patient with a recurrent

(5) GELLHORN GEORGE Combined Intra abdominal and Intra-vaginal Irradiation in the Treatment of Carcinoma of the Cervix Am Jour Surg March, 1935 27, 422-424

(6) HEALY W P Treatment of Carcinoma of the Cervix Uteri Ann Surg, January, 1931, 93, 451-459

(7) Idem Carcinoma of the Cervix RADIOLOGY March 1930, 14, 217-222

(8) HEALY W P and ARNESON A N Radiation Treatment of Carcinoma of the Cervix Am Jour Roentgenol and Rad Ther, November 1934, 32, 646-653

(9) Idem A Study of Carcinoma of the Cervical Stump Developing after Subtotal Hysterectomy Am Jour Obst and Gynec March 1935 29, 370-383

(10) LUCAS, C DE F The Calculation of Dosage in the Radium Treatment of Carcinoma of the Cervix

Am Jour Roentgenol and Rad Ther, 1937, 36, 477-489

(11) - PITTS H C, and WATERMAN, G W The Treatment of Cancer of the Cervix Uteri at the Rhode Island Hospital A Report of 293 Cases with Five-year Follow-up Surg Gynec and Obst January 1937 64, 30-38

(12) QUIMBY E H Physical Factors in Interstitial Radium Therapy Am Jour Roentgenol and Rad Ther, March, 1935 33, 306-316

(13) TAUSSIG F J Iliac Lymphadenectomy with Irradiation in the Treatment of Cancer of the Cervix Am Jour Obst and Gynec November, 1934 28, 650-667

(14) WARD GEORGE GRAY and SACKETT, NELSON B Radium Therapy of Carcinoma of the Cervix Uteri Surg, Gynec and Obst, February 1935, 60, 495-499

ministered by inserting four needles of 66 mg strength with an active length of 20 cm into the cervix and left parametrium, and seven needles of 10 mg strength with

right parametrium extending into the region of the right ureter. Additional treatment was administered, but sufficient time has not elapsed to determine the degree of



Fig 3 Arrangement of sheath needles holding platinum cells (total filter equivalent to 0.5 mm Au) employed in the treatment of a patient with a hard nodular recurrence involving the left parametrium and extending along the anterior vaginal wall into the base of the bladder. The longer needles have an active length of approximately 20 cm and contain 66 mg radium each. The shorter needles are 10 mg strength with an active length of approximately 10 cm.

an active length of 10 cm into the anterior vaginal wall. The stronger needles were removed after 48 hours, but the weaker sources were used for five days (120 hours). The total dose was approximately 2,100 mg-hr. There was very little evidence of reaction following the treatment, and consequently there was only slight evidence of regression. However, the degree of palliation was satisfactory, and the bladder symptoms were relieved. Seven months after treatment the patient complained of pain in the back and in the left pelvis. This was attributed to obstruction and dilatation of the left ureter, noted cystoscopically and radiographically. There was also beginning involvement of the

palliation that will be obtained. The function of the right kidney has remained adequate, and the patient has been comfortable.

Due to their lower intensity of radiation, relatively weak sheath needles may be used to deliver doses considerably greater than those obtained from the stronger and more lightly filtered steel needles. Weak sources several centimeters in length implanted into the parametrial region can be used for doses far greater than the amounts reaching those regions from radium placed in the uterus and the vagina. However, the needles must be implanted with care and in a manner that will irradiate the entire region. In Figure 4 is shown a radiograph illustrating a rather

tion patterns are produced, then it follows that x-rays may be expected to make a third great contribution to the field of medicine, in addition to diagnostic radiography and therapy, namely, a "supermicroscopic" analysis of biologically significant materials. It is the purpose of this paper to present very briefly an account of present knowledge of results on such materials. It will become immediately apparent that only the barest beginning has been made and yet the great promise of this application of x-rays is unmistakably indicated. An outline of the materials to be briefly considered as typical examples, and by no means a complete list, is as follows:

- I Cellulose
 - 1 Polymorphic forms native, mercerized, Cellulose III
 - 2 Variations in orientation
 - 3 Regenerated cellulose
 - 4 Cellulose esters and compounds
- II Chitin
 - 1 Structure, orientation, reactions
 - 2 Chitosan
- III Rubber
 - 1 Structure on stretching
 - 2 Sol and gel
 - 3 Freezing and crystallization
- IV Proteins
 - 1 Fibrous
 - (a) Silk fibroin
 - (b) Hair keratin
 - (c) Feather keratin
 - (d) Gelatin and collagen
 - (e) Muscle myosin
 - (f) Living nerve
 - 2 Globular
 - (a) Albumin
 - (b) Hemoglobins
 - (c) Insulin, pepsin, etc
 - (d) Crystallized virus

I Cellulose—Cellulose forms the principal, and usually the crystalline, part of a large number of plants including ramie (Fig 2), flax, jute, sisal, hem and cotton, wood, walls of the single-celled organism *Volvox*, bacterial cellulose and tunicin, or animal cellulose. All these types of native cellulose possess the same fundamental struc-



Fig 2 Typical diffraction pattern for ramie, one of the natural cellulose fibers. Small bundles of the fibers are laid parallel and the x-ray beam transmitted perpendicular to the fiber axis. This pattern shows a high degree of crystallinity all of the interferences being due to cellulose and also a high degree of fibering or, in other words, a pronounced preferred orientation of cellulose crystallites with respect to the fiber axis. From such a pattern the complete crystal structure of cellulose is deduced.

ture, and differ only in respect to the relative orientations of cellulose crystallites and in the cementing and embedding materials. The giant molecules consist of a long chain of glucose residues ($C_6H_{10}O_5$) held together by 1-4 glucosidal oxygen bridges. The unit crystal cell is small and contains, of course, only a small number of the parent glucose residues, paired together as cellobiose. Thus, the length of the unit cell along the fiber axis, 10.3-10.4 Å, corresponds to the cellobiose unit, while the macromolecule extends through many such cells to a length corresponding to a molecular weight as high as a half-million. The accepted data on cellulose have been those of Meyer, Mark and Andress, as follows:

ably located medial to the long radon needles, and above the points of the shorter radium needles. The patient has been ob-

in every instance it is essential to employ a method that will deliver the most suitable distribution of radiation for the lesion

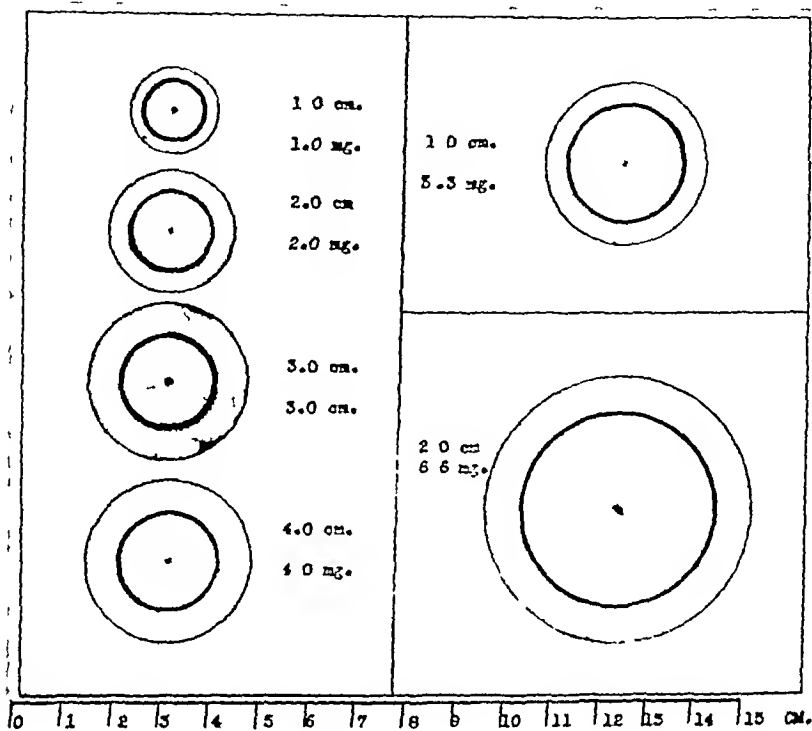


Fig 5 Isodose charts prepared from radiographic film for needles with 0.5 mm Au filter of specified lengths and strengths. The curves illustrate the distribution of different threshold doses along a line perpendicular to the middle of each source for 133 hours radiation (1.0 mc destroyed per milligram strength). The distribution of one threshold dose is indicated by the periphery of each disk. The curve for two threshold doses has been scratched upon the film by means of dividers and the groove colored with ink.

served for one year, and the residual mass has not increased in size. There was no reaction following treatment except rather severe cystitis, which was controlled by frequent bladder irrigations and medications.

The film of this patient is shown primarily to illustrate the importance of a predetermined tissue dose and method of treatment. The lack of a definite plan for inserting the needles can be seen readily in the radiograph. While the end-result was better than had been expected, a portion of the disease was irradiated inadequately because of the careless distribution of the sources. It is, of course, impossible to implant needles with exact precision, but

under treatment. In general, the therapy failures have been more instructive than the successes, and the patients discussed here have been selected to illustrate the value of interstitial radiation in cases of primary and recurrent carcinoma of the cervix presenting particular problems in treatment. If in every instance the treatment is carefully planned and individualized for the patient in question, it can be administered without risk of severe injury or other complications.

The planning of treatment for a given individual can be divided into three important steps. One must first decide upon a minimum tissue dose considered adequate for the lesion in question. It is

types and degrees of preferred orientations of cellulose crystallites with respect to given directions. Quantitative measurements, experimental synthesis of all types of patterns, and correlation with physical properties have been presented by Dr W A Sisson and the writer in a series of papers on natural and regenerated fibers and membranes.

II Chitin—Chitin is the compound that makes up most of the organic part of the skeletons of *Arthropoda*. In the animal kingdom, to which it is limited with very few exceptions, it occurs only in the invertebrates. In addition to forming the exoskeletons of insects, *Crustacea* etc., it is the major constituent of the lenses of the eyes, the tendons, and the linings of the respiratory, excretory, and digestive systems.

Chitin is remarkably similar to cellulose in formation of long carbohydrate chains except that it contains nitrogen, thus moving a step toward the familiar proteins of the vertebrate world.

Chitin produces very rich fiber diffraction patterns from which is deduced the crystal structure² (Fig 3). This is probably orthorhombic with the unit cell dimensions

$$\begin{aligned} a &= 9.25 \text{ \AA U} \\ b &= 10.46 \\ c &= 19.25 \end{aligned}$$

As laid down in sheets, the only orientation is that the *b* axes are parallel to the surface. At a temperature of 200°C chitin forms a definite addition compound with lithium thiocyanate, while at lower temperatures intramolecular swelling occurs. Various fractions of chitin nitrate have different average lengths of the carbohydrate chain. Chitin nitrate is orthorhombic with

$$\begin{aligned} a &= 9.2 \text{ \AA U} \\ b &= 10.3 \\ c &= 23.0 \end{aligned}$$

A whole series of compounds is formed with sodium hydroxide, but it is difficult

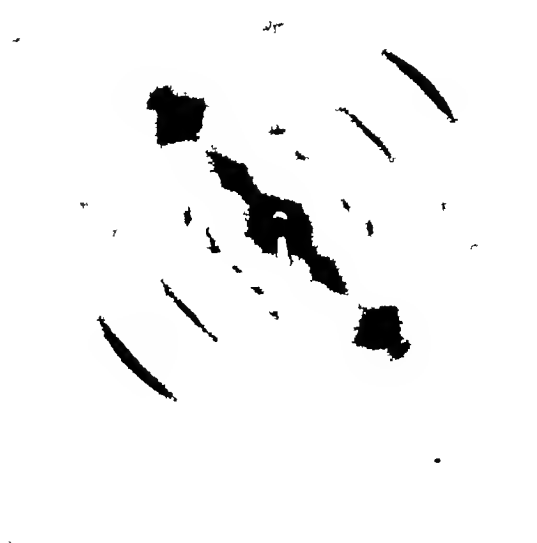


Fig 3 Pattern for the mandibular tendon of a lobster composed of pure chitin. This substance is closely related to cellulose and it has a similar crystalline structure. However chitin contains nitrogen atoms. This is one of the most remarkably organized and crystalline of all natural materials. The shells of insects and the outer shell of lobsters and other crustaceans are composed of chitin as the organic part. The hard shells of course contain inorganic salts which can be removed by acid treatment. A very complete study of chitin and its chemical reactions has been published in the *Journal of Physical Chemistry*.

to isolate pure compounds and to obtain sharp patterns because of hydrolysis.

Chitosan is the compound formed by hydrolysis of half the acetyl groups in chitin. When formed from a sheet, it undergoes a change to a more restricted orientation such that the 002 planes become parallel to the surface of the sheet. The unit cell of chitosan (monoclinic) has the dimensions

$$\begin{aligned} a &= 8.9 \text{ \AA U} \\ b &= 10.25 \\ c &= 17.0 \\ \beta &= 88^\circ \end{aligned}$$

Like chitin, chitosan forms a long series of interesting addition compounds with distinctive patterns. While chitin gives a con-

² Clark and Smith Jour. Physical Chem. 1937 40, 583

imum dose delivered to the diseased area without administering excessive amounts from any particular source

For determining the amount of radiation necessary to deliver a predetermined dose for a given arrangement of radium, it is necessary first to estimate the volume of the region in question, and then consult tables published by Qumby (12) showing the amount of radiation required for delivering various threshold doses to specified volumes. Such procedures are sometimes complex, and for cervical cancer the degree of accuracy is not great, because of the large volume of the tumor-bearing region, the difficulty of determining its dimensions, and the differences in strength of source which must be used (1 c, tandem, needle, etc). In many patients it is necessary to plan the treatment upon the physical principles of interstitial radiation and consider the effect of length, strength, filter, distance, etc., upon the dose arriving at various points from each source. In such instances the approximate size and location of the region in question is indicated upon a diagram, and the distribution of radiation calculated for different arrangements of needles, tandems, special applicators, etc., in the attempt to determine the method best suited to the treatment of that individual.

Those procedures are both tedious and complex. As an aid in calculating tissue doses, isodose charts were prepared for interstitial sources which can be used for radium in the same manner as depth dose charts prepared by others have been used for x-rays. However, instead of showing percentage depth doses the curves for radium were drawn to indicate the distribution of various threshold doses along a line perpendicular to the middle of the source. In view of the fact that the isodose curves were drawn for threshold doses instead of relative amounts arriving at various depths, it was necessary that each chart be prepared for a specified number of milligram-hours' radiation. In order that the curves for different sources might be compared, the dose was standardized by employing

a definite period of time for that was chosen 133 hours. Therefore, each set of curves represents the distribution of threshold doses for 1 mc.-destroyed per milligram strength of the source in question.

Isodose charts were first prepared for a number of needles with different active lengths and containing different amounts of radium. The sources selected for charts were chosen from various sheath needles holding platinum cells that might be used in the treatment of gynecologic carcinoma. Data were taken from publications by Qumby (12) for calculating the depths that various threshold doses are delivered by specified sources for 1 mc.-destroyed per milligram strength. Since the distribution of radiation is shown along a line perpendicular to the middle of each implant the curves about that point form a circle, and the isodose charts appear as circular disks. For practical use it is convenient to make them from discarded radiographic film as shown in Figure 5.

Due to the rapid falling off of intensity within a few millimeters of each source, it is impractical to indicate on the disks more than one or two isodose curves. The outer edge of each disk has been used to indicate the distribution of one threshold dose, and by means of dividers an inner circle has been scratched on the film to show the distribution of two threshold doses. The distances to which the different doses are

TABLE I—NEEDLES

Active Length (cm.)	Strength mg Radium	Total mc destroyed	Distance Threshold Doses Delivered (cm.)	
			1 T D	2 T D
1 0	1 0	1 0	0 9	0 6
	3 3	3 3	1 7	1 2
	2 0	2 0	1 3	0 8
2 0	6 6	6 6	2 8	2 0
	3 0	3 0	1 6	0 9
4 0	4 0	4 0	1 7	1 0

Distances that one and two threshold doses are delivered along a line perpendicular to the middle of different needles with 0.5 mm Au filter. The active length and radium content of each source is specified. Calculations are made upon the basis of 1 mc.-destroyed per milligram strength.

course, total rubber) is responsible for the fiber pattern upon stretching. The latter, furthermore, has a characteristic long-

to a new molecular configuration at 65° . In the fully extended rubber chain the molecular groups are in *cis* position, while

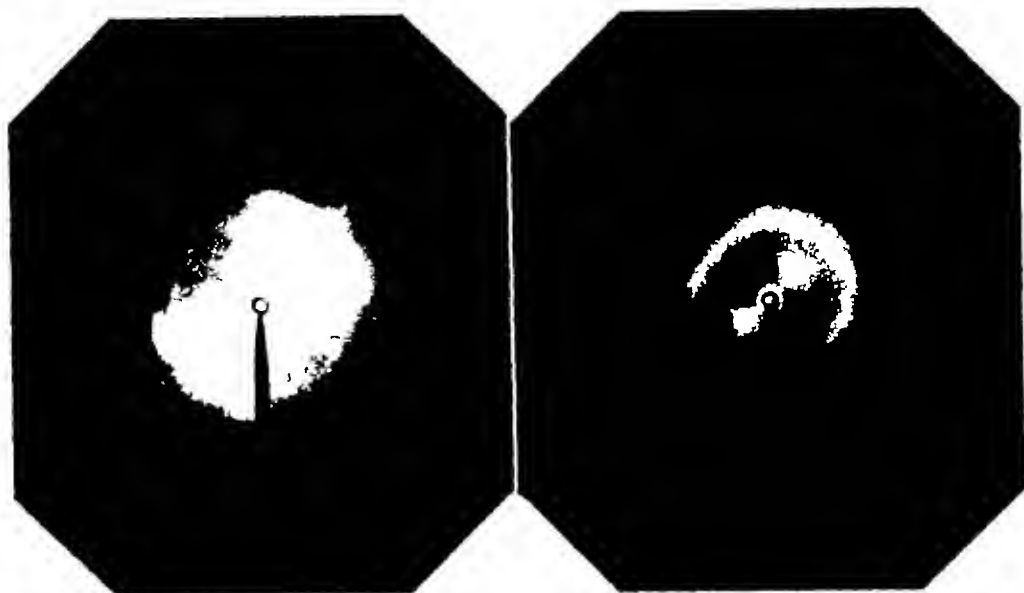


Fig 5 (left) Pattern for natural silk—a protein called 'fibroin' synthesized by the silk worm. Cobwebs give an entirely similar pattern.

Fig 6 (right) Pattern for human hair or keratin. When hair is stretched this pattern changes completely into a new molecular configuration, which accounts for many of the peculiar properties of hair and wool.

spacing of 54 \AA U (or a multiple) which is completely lacking in sol rubber. Sol rubber, upon vulcanization, can be made to produce a fiber pattern as a further confirmation of the concept that sulphur forms stiffening cross-linkages between long backbone molecules.

When rubber is kept cold for a long time it becomes opaque and the "amorphous" halo pattern gives way to a sharp line pattern characteristic of a powder. An analysis in the writer's laboratory proves that these true crystals possess essentially the structure already derived from the fiber pattern produced on stretching. Identical with these patterns are those for *pure sol* and *gel crystals* produced at the National Bureau of Standards.

Gutta-percha, balata, and chicle have also the general formula $(C_5H_8)_n$ but differ widely from rubber. They are crystalline at ordinary temperatures without stretching, and undergo a polymorphic transition

in gutta-percha these are in *trans* position



Fig 7 Pattern of the feather of a bird. Also keratin but decidedly more crystalline and differently oriented.

ample, gold or platinum sheath needles holding one or more cells containing 10 or 33 milligrams radium each) is probably of importance in reducing the risk of severe tissue reactions. However, the most important factor in the prevention of untoward sequelæ following the use of interstitial radiation, or any other method of applying radium is the careful planning of the treatment for each patient.

To avoid accidents and reduce the number of failures of treatment it should be emphasized that it is essential to decide first upon a predetermined dose considered adequate for the lesion in question, and then to apply that amount by a method which will deliver a distribution of radiation suited best to the volume to be radiated. It should be noted here that estimations of tissue dose can be only approximate, and by no means can radium be applied with precision in every case. However, some method for arriving at a predetermined plan of radiation is essential for individualizing the treatment of each patient in the attempt to improve the results now obtained.

SUMMARY AND CONCLUSIONS

No single plan of radiation is suitable for all patients with cervical cancer. If the percentage of cures is to be increased materially, it is essential to individualize both the roentgen and radium treatment of each patient, rather than to apply a single method to all individuals.

Two important factors should be considered in planning the treatment of every patient: one, the minimum tissue dose necessary to control the lesion in question, and, two, the distribution of radiation throughout the tumor-bearing region. An intra-uterine tandem alone is inadequate for most patients with cervical cancer, due to the large dose falling upon the primary lesion and the relatively small amount arriving in the parametrial regions. The parametrial dose can be increased without administering excessive amounts from any particular source of radium if a greater

number of sources are distributed throughout the tumor-bearing region.

Four patients in whom needles were employed in the treatment of primary or recurrent carcinoma of the cervix have been discussed. The location of the different sources used in each patient has been illustrated by means of radiographs made during the time radium was in place. A predetermined plan of radiation was worked out for each individual. The attempt was made to administer a tissue dose considered adequate for the lesion in question, and to deliver a distribution of radiation suited best to the volume of tissue to be treated.

There have been prepared for radium, isodose charts that can be used in the same manner as depth dose charts prepared by others have been used for x-rays. The method of preparing the charts has been described in detail. The isodose curves have proven to be useful aids in teaching the principles of interstitial radiation. They present a fairly rapid method for determining amounts of radiation required for delivering a predetermined tissue dose considered adequate for a given lesion. Furthermore, use of the charts necessitates a careful planning of radiation that insures individualization of treatment.

The author wishes to acknowledge his indebtedness to Edith H. Quimby, of the Department of Biophysics, Memorial Hospital, New York City, for her invaluable assistance and many helpful suggestions made during the preparation of this work.

BIBLIOGRAPHY

- (1) ARNISON A. N. The Distribution of Radiation within the Average Female Pelvis for Different Methods of Applying Radium to the Cervix. *RADIOLOGY*, July 1936 27, 1-20.
- (2) ARNISON A. N. and QUIMBY E. H. The Distribution of Roentgen Radiation within the Average Female Pelvis for Different Physical Factors of Irradiation. *RADIOLOGY*, August 1935 25, 182-197.
- (3) ARNISON A. N. and STEWART F. W. Clinical and Histologic Changes Produced in Carcinoma of the Cervix by Different Amounts of Roentgen Radiation. *Arch Surg*, October 1935 31, 542-567.
- (4) FRAZELL E. L. Correlation of Calculated Tumor Doses and Five Year Survivals in Radiation Therapy of Cancer of the Cervix. To be published in *Am Jour Roentgenol and Rad Ther*.

lyzed and reformed in a configuration which will prevent return to the folded α -state. The α -form has the main-chains folded so that the grids are buckled. Now wool and hair can be treated by steam or alkali in the extended state so that upon release they exhibit supercontraction to a length shorter than normal. Thus the α -folding is still further elaborated to about one-third the length of β -keratin and must be due to fundamental changes in the cross-linkages of the grid as demonstrated actually on the x-ray patterns.

Feather keratin produces a remarkably rich pattern which is based fundamentally on the simple α - and β -keratin structures and pattern, but greatly elaborated and actually approaching some of the crystallized proteins (Fig. 7).

Muscle—All of the above observations on diffraction patterns, structure, behavior on stretching and supercontraction in keratin have now been duplicated by Astbury for the protein in muscle, namely, myosin. The photograph of washed and dried muscle, and indeed of living muscle, if the presence of water is taken into account, is remarkably like that of α -keratin, that of stretched myosin is also like that of β -keratin. Hence, myosin possesses folded chains in the condition at rest, which are further folded upon supercontraction. Since keratin possesses a much higher sulfur content from its cystine constituent, the side linkages between neighboring chains may be through the $-S-S-$ groups, so that a hair may be considered as a "vulcanized" muscle fiber with reduced elastic sensitivity and increased resistance to chemical attack.

Collagen—The principal constituent of vertebrate tendons and tissues is the protein collagen, which, upon hydrolysis, yields gelatin. Surgical catgut ligatures are collagen fibrils from the intestinal walls of sheep. An extended x-ray study of catgut in the writer's laboratory has led to greatly improved processing of the ligatures in the sense of uniformity and enhanced tensile strength. This was achieved largely through improved pre-

ferred orientation of protein crystallites under combined swelling and tension.⁵

Collagen and gelatin, being made up of fifteen or more amino acids of widely different functional groups and molecular weights have previously not given patterns with sufficient orientation and number of interferences to lend themselves readily to analysis. Long-chain molecules are rather easily oriented by tension but lack sufficient organization of amino acid residues to produce a well-defined lattice. The existence of a halo, which shows indication of partial orientation, superimposed upon a faintly sharp interference pattern indicates a "pseudo-crystalline" structure. On the pattern appears inner equatorial arcs for a spacing of from 10.4 to 17.0 Å U, depending on the amount of water held by the protein and measuring the distance between main chains, or the length of cross-linkages, a spacing of 4.5–6.1 Å U corresponding to the thickness of the grid, and a fiber axis identity period of 9.75 Å U, or three times an amino-acid residue length of 3.25 Å U. Another spacing of 2.84 Å U, thought by Astbury to be a contracted residue length, is due to planes which are not perpendicular to the fiber axis. Both collagen and stretched gelatin ribbons give essentially this same type of ordinary pattern.

Clark, Parker, Schaad, and Warren⁶ first reported the existence of a spacing along the fiber axis in collagen of 432 Å U (the longest ever directly measured) which is completely missing in gelatin. This gives a remarkable clue to the organization of collagen in contrast with gelatin. This spacing indicates a regularly repeating residue along the chains or an over-all length of the molecules themselves. In addition, a lateral equatorial spacing of 48 Å U is noted for intestinal wall but not for tendon collagen. The orthorhombic unit cell of the addition compound amino-

⁵ The X-ray in the Study of the Catgut Ligature, G. L. Clark and P. F. Ziegler, *Surgery, Gynecology and Obstetrics*, 58, 578, *Surgical Ligatures*, Clark, Ilego and Ziegler *Ind Eng Chem*, 26, 440.

⁶ *Jour Am Chem Soc*, 1935 57, 1509.

ANALYSIS BY X-RAYS OF ULTIMATE STRUCTURES OF LIVING MATERIALS¹

By GEORGE L. CLARK, Ph D, *Urbana, Illinois*

From the Department of Chemistry, University of Illinois

SINCE the discovery in 1912 by von Laue and associates that crystals are three-dimensional diffraction gratings for x-rays, by virtue of the regular arrangement of the atoms and molecules

sor W. L. Bragg, began building upon the von Laue discovery and to this day retain their great leadership in the field. They demonstrated at once that a simple relationship governed the diffraction phenomenon and connected x-ray wave length, crystal interplanar spacing, and the angle of incidence, namely, the Bragg law

$$n\lambda = 2d \sin \theta$$

where n is an integer (the order of reflection), the λ -ray wave length, d the spacing of a set of parallel planes in a crystalline substance, and θ the angle of incidence, or 2θ the angle of diffraction, of a pencil of rays

In a comparatively short space of time hundreds of chemical compounds, inorganic and organic, metals, alloys, colloids, and materials of every imaginable variety have been subjected to x-ray diffraction analysis, with the result that indispensable information has been obtained upon what may be termed Nature's building plan, which is interpreted directly from the diffraction pattern. It is essential for such an interpretation, of course, that the material under investigation should have a spatial regular arrangement such as is readily inferred from a crystal of rock salt (Fig. 1) but scarcely from a cotton fiber or living nerve. And yet liquids and glasses, which are to be classed as amorphous in the usual sense, actually yield valuable data from the two or three broad halos which they produce as a pattern.

A reasonable and intriguing extension of the diffraction technique is, of course, to the great range of complex, highly polymerized materials which are formed in living processes. If it is found that these materials are sufficiently well organized in the sense of ordered arrangement of giant molecules, so that characteristic diffrac-

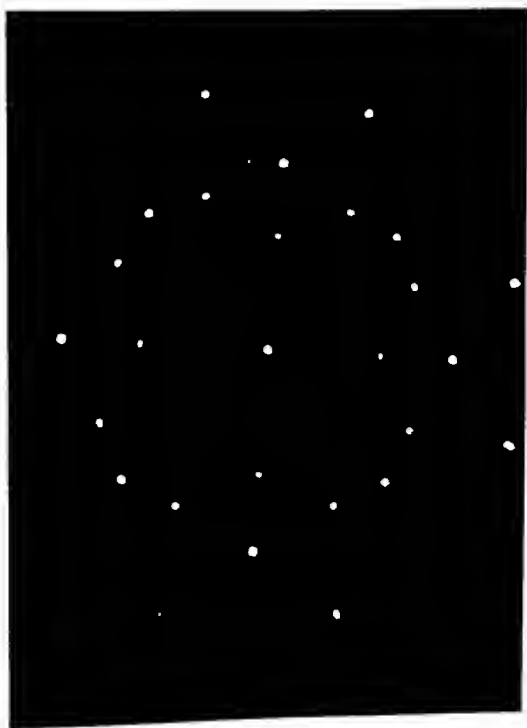


Fig. 1. Laue pattern for single crystal of rock salt displaying cubic symmetry. By this same method in 1912 Laue discovered the diffraction of x-rays by crystals. Also, by this method a very narrow pencil ray defined by pinholes is transmitted through a stationary single crystal and the pattern registered on the photographic film at a fixed distance from the specimen.

upon lattice planes having spacings commensurate with x-ray wave lengths, a great chemical science of ultimate architectural structures of materials has risen to an eminent and well recognized place. Sir William H. Bragg and his son, Profes-

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

cylinder give spacings similar to those of collagen of the connective tissue

Artificial fibers spun from the nucleoproteins of lobster nerves, though positively birefringent, indicate no orientation in their diffraction patterns. A ring of 9.1–11.5 Å represents the proteins. Even though these fibers were spun from fat-extracted protein, rings at 48, 23, and 4.8 Å represent the lipid components.

Alcohol-dried lobster nerves show equatorial sickles at approximately the same spacing as that given by the nucleoprotein of the axis cylinder. This fact was originally interpreted as showing that the axis cylinder contains oriented protein micelles. This conclusion must be qualified in view of the demonstrated presence in these nerves of collagenous material which might be responsible for at least a part of the orientation.

Although lipoids are present in very appreciable quantities in lobster nerve, they give rise to no pattern in fresh nerve. However, if the nerve be treated with glycerine, which changes the birefringence from positive to negative, patterns may be obtained which demonstrate that the lipoids have become oriented. Preliminary experiments indicate that cholesterol and perhaps also the phosphatides are involved in the effect.

The nerve of the squid represents the nearest approach to a pure giant axon yet found. This material, though displaying weak birefringence, presents an essentially amorphous pattern. It is estimated that only about 8 per cent of the long-chain protein molecules in the axis cylinder are actually in any preferred orientation.

Globular Crystalline Proteins—The obvious limit of the idea of folding and twisting protein chains is to be found in the so-called globular proteins such as egg albumin, hemoglobin, edestin, etc. These substances may actually be crystallized in a sense far different from the fibers just discussed. It would appear that they are built in a very delicately balanced fashion of somewhat spherical units which have been shown so brilliantly in the work of

Svedberg with the ultra-centrifuge, to have molecular weights of 35,000 or a multiple. X-ray work by Bernal and Crowfoot⁸ on pepsin and insulin crystals have definitely confirmed this contention. Clark and Shenk⁹ have made an extensive study of crystallized and denatured egg albumin. In the usual case the patterns for these proteins consist essentially of two halos corresponding to the two principal distances between main chains, 10 and 4.5 Å. By boiling and other methods of denaturation, the pattern resembles even more strongly that of powdered or disoriented β -keratin, showing that a highly specific and delicately balanced configuration in the original globular protein is broken down. By stretching, Astbury has succeeded in orienting denatured albumins and globulins so that fiber patterns are produced. Thus denaturation actually liberates polypeptide chains from crystalline proteins and permits their conversion into visible fibers which, on stretching, are found to be structurally analogous to stretched wool and unstretched silk.

Clark and Shenk¹⁰ have shown that denatured hemoglobins give diffraction patterns very similar to those of egg albumin. X-ray studies are made of rat and horse oxyhemoglobin and horse and pig carbon monoxide hemoglobin. The two horse hemoglobins with a maximum spacing of 48.2 Å seem to be the same, but the patterns for blood from different animals are not alike. The color constituent of hemoglobin, hemin, chlorohemin, potassium oxyhemin, and other derivatives are all identical from all sources.

Of greatest recent interest has been the x-ray analysis of crystallized tobacco mosaic virus protein, isolated first by Dr W. M. Stanley, of the Rockefeller Institute for Medical Research. The significance lies in the attempt to explain how this material, placed in the proper environment, is able to produce more of itself, and whether, or how closely, a crystalline protein comes to

⁸ Nature 1934, 133, 794; 1935, 135, 591

⁹ RADIOLOGY, 1937, 28, 58

¹⁰ RADIOLOGY, 1937, 28, 144

- a = 8.35 Å U
- b = 10.3 (fiber axis)
- c = 7.95
- $\beta = 78^\circ$ (monoclinic system)
- 4 $C_6H_{10}O_5$ groups per unit cell

By an analysis of intensities the parameters of carbon and oxygen atoms were determined and more recently corrected to give the most accurate picture of the cellobiose unit and the disposition along the edges and in the center of the unit cell. More recently, however, Sauter, by greatly improved technique, was able to register more than forty interferences which have not hitherto been observed on patterns, with the result that an entirely different interpretation is made, as follows:

- a = 10.8 Å U
- b = 10.4
- c = 11.8
- $\beta = 85^\circ$
- 8 $C_6H_{10}O_5$ groups per unit cell

This is in remarkable agreement with the original structure proposed by Sponnier and Dore, namely,

- a = 10.7 Å U
- b = 10.3
- c = 12.2
- $\beta = 90^\circ$ (orthorhombic)

An entirely different configuration of the chain is proposed so that the two glucose rings for cellobiose are not in the same plane.

Meyer and Mark presented the picture of rod-like cellulose micelles or crystallites about 300 Å U long and 50 Å U in cross-section, from a measurement of the breadths of diffraction interferences. Clark and Parker, by refined technique, studied the diffraction effects at very small angles, corresponding to very large spacings. There is a continuous series instead of sharp spots, running up to several hundred Å U, laterally between cellulose chains or particles, suggesting considerable variability in these dimensions. Sauter

has dismissed entirely a micellar or crystallite structure in favor of true long macromolecules ten times as long as the supposed micellar length of Meyer and Mark. The structure then consists of crystalline portions, amorphous interstices, and ultra-crystalline-fibrillar lattice splitting, to account for the highly complex physical and chemical behavior of cellulose. In 1934 the writer proposed that the ellipsoidal particles of cellulose, which appear when a pectin-like cementing material is chemically dissolved, with a constant length of 1.5 μ and cross-section of 1.2 μ , actually represented a bundle of chain molecules with a maximum length of 1.5 μ . Such a chain would have a molecular weight of nearly a half-million in agreement with measurements by the ultra-centrifuge and by Staudinger's viscosity method.

Mercerized cellulose, prepared by treatment of native cellulose with alkali solutions followed by removal of all the alkali, is a polymorphic form of cellulose in which the chains are disposed differently with respect to the principal crystallographic directions in the unit cell and to each other. The monoclinic angle is considerably more acute (62°). This structure is consistent with observed characteristic properties such as ease of dyeing, greater absorbent properties, etc. Cellulose III is prepared by swelling native or mercerized cellulose in liquid ammonia, thus forming a complex ammonia-cellulose, followed by removal of the ammonia. Here the monoclinic angle is 58° and the interplanar spacings differ from those of the other two varieties.

Cellulose is characterized by a very long list of so-called topochemical reactions—the conversion of one crystal form into another in a fiber without destroying or indeed even seriously affecting the fiber in over-all structure or strength. Nitration, acetylation, reactions with alkalis, amines, etc., are all representative of important products which have been studied and identified by the x-ray method.

The various native cellulose fibers and sheets are distinguished by widely varying

THE EVOLUTION OF RADIOTHERAPY, DURING THE PAST TEN YEARS, IN THE TREATMENT OF CERTAIN GENERALIZED AFFECTIONS¹

By RENÉ GILBERT, M D , *Geneva, Switzerland*

Professor of Medical Radiology at the University of Geneva

Translation by A U DESJARDINS, M D , The Mayo Clinic, Rochester, Minn

THANK the organizing Committee of the Congress, and especially our Section Chairman, Dr Desjardins, for the honor of having been selected as honorary chairman of this session

The radiologists of Europe have the privilege of meeting this year in a country which offers them perspectives which are very original and full of instruction. Thanks to our congresses, we come to know not only the ways and methods of work of each ethnic group, but also the men and the spirit which animates them. We congratulate ourselves on being in the midst of our American colleagues and on being able to approach the radiologic élite of the New World.

These congresses also enable us to obtain our bearings in certain controversial questions. This is why it seemed worth while to open this session by seeking what new developments the methods of irradiation have brought us during the past ten years, that is, since the appearance of total telecoerthotherapy.

In order to keep within the time limit, I have chosen chronic leukemia, essential erythremia, and malignant granulomatosis. I do not pretend to bring you decisive ideas. I intend merely to express an opinion concerning a complex problem which we are not yet in position to solve.

Before 1927, except for experiments on animals and for an early, technical rather than clinical attempt by Dessauer, the classic method of applying radiotherapy consisted in local, segmental irradiation of the human body, whether one was dealing with circumscribed lesions or with a generalized affection.

Even during the early days of radiotherapy, leukemia and granulomatosis (Hodgkin's) were classed among the very radiosensitive conditions, the new method, which constituted a great progress, gradually imposed itself, it became the dominant treatment of these frightful diseases, without, however, being able to claim rank as a curative agent.

Might we find, thanks to improvements in technique and to more powerful apparatus, a more rational method which, in conditions so widely disseminated through the body, might serve to improve the results of this palliative agent? The idea of irradiating the entire body in a single field was tempting. Werner Teschendorf, as well as Dale, deserves the credit of having opened new horizons by different paths.

The method and the results of segmental radiotherapy are familiar to us all, I need not recall them to you.

What objections have been raised against the classic method? Against it has been held the inability of prolonging life in these diseases. It yields remissions of excellent quality, but death supervenes in the same time, whether the patient has been irradiated or not. At least, this is true in the leukemias, as has been shown by Minot (1924) and Hoffman and Craver (1931). As for malignant granulomatosis (Hodgkin's disease), the case is different. The idea advanced in 1924 by Klewitz and Lullies, and by many other authors, is no longer warranted if the method of irradiation is correct. The majority of cases present more definite and longer remissions and life is incontestably prolonged. I have submitted proof of this at the General Session, I shall not repeat it now.

¹ Presented before the 15th International Congress of Radiology, in Chicago Sept 13-17 1937

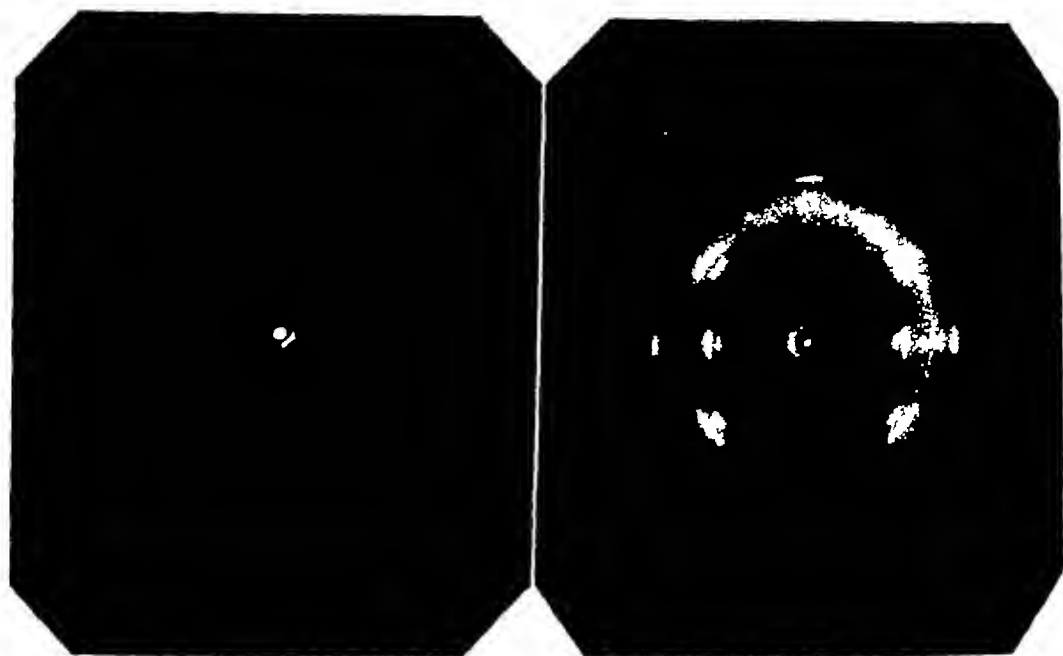


Fig 4 Patterns for unstretched rubber and the same rubber stretched 500 per cent. The former pattern is characteristic of a liquid or glass with a single broad halo. When rubber is stretched long tangled molecules are apparently pulled into parallel alignment and crystallization and fibering are the result. From such a pattern a great contribution has been made to the knowledge of the structure of rubber. Rubber may be separated into two fractions, ether-insoluble or gel rubber, and ether-soluble or sol rubber. Only the total or gel rubber produces a pattern of this kind upon stretching, while sol rubber does not, even at 1 000 per cent elongation. Also gel rubber produces a long spacing close to the center of 54 Ångström units, which is completely missing in sol rubber.

tinuous series of long equatorial spacings like cellulose, chitosan produces resolved maxima in several orders corresponding to a definite lateral spacing between molecular chains or crystallites of 75 Å U. This spacing increases markedly upon swelling in dilute alkali.

III Rubber—As an example of coagulated latex produced by numerous plants, we may select rubber (*Hevea brasiliensis*). X-rays have made a notable contribution to the knowledge of this remarkable substance. Ordinary unstretched rubber produces a pattern characterized by two or three broad halos exactly as a liquid or glass. Instantly upon stretching, however, a rich crystal fiber pattern is obtained which has led to an evaluation of the structure of these polymerized C_5H_8 chains (Fig 4). The fibering appears only beyond a critical elongation which depends upon the state of the specimen, vulcanization, temperature, solvent, or fractionation. The

approved data³ for the monoclinic unit cell are as follows:

$$\begin{aligned} a &= 8.54 \text{ Å U} \\ b &= 8.20 \\ c &= 12.15 \\ \beta &= 83^\circ 20' \end{aligned}$$

Space group C_{2h}^2 , four principal valence chains for cell



The long chains have a two-fold screw axis of symmetry. The actual crystallite is a molecular racemate of right- and left-handed spiral molecules.

Comprehensive work has been done on the ether-soluble (sol) and ether-insoluble (gel) phases of rubber in the writer's laboratory. Sol rubber will not produce a fiber pattern even upon stretching above 1,000 per cent, while gel rubber (and, of

³ Lotmar and Meyer. Monatshefte für Chemie 1936 69, 115. Clark, Wolthuis and Smith. National Bureau of Standards Jour. of Research 1937 19, 1039.

decrease in the leukocytes, erythrocytes, and hemoglobin in one case (as much as 600 leukocytes per cubic millimeter, a million erythrocytes and 20 per cent in the hemoglobin) Cottenot and Sluys write "Everything takes place as if the massive destruction of lymphocytes in the tissues and in the blood liberated toxins capable of destroying erythrocytes"

ERYTHREMIA

Erythremia (synonyms—Vaquez' disease, essential polerythrocythemia, polycythemia rubra) deserves special consideration. When irradiation of the spleen had been shown to exert only a mediocre influence, my colleague, Ludin, of Basel, was the first to demonstrate the necessity of irradiating the bone marrow. This mode of irradiation by innumerable small fields yielded brilliant successes, but it had the disadvantage of being tedious and costly, and was not always successful. As early as 1928, Sgalitzer applied total teleroentgentherapy to this disease. In 1937 he reported that of 44 irradiated cases, 42 had responded favorably to teleroentgentherapy, many of them having proved refractory to segmental irradiation of the bone marrow. The results are frankly encouraging. As in leukemia, there is no cure, but recurrence appears to be the more delayed as the first series of irradiations has been more thorough. The number of erythrocytes should be reduced progressively to 4,000,000, without the leukocytes ever falling below 3,000. This depends on the dose at each session and on the rhythm of irradiation. Several authors have confirmed these results.

At the present time, Sgalitzer concludes that, if total teleroentgentherapy as compared with segmental irradiation constitutes a remarkable progress in the treatment of leukemia, the results which it yields in erythremia are even superior.

Quite different are the results of this method in malignant granuloma (Hodgkin's disease). In this condition panteleroentgentherapy produces such strong general reactions that the protagonist of the

method, Teschendorf himself, has given it up. He prefers roentgentherapy of the entire trunk through large and separate fields (Sluys), combined with local irradiation of the tumors. Personally, I am opposed to panteleroentgentherapy for granulomatosis, for the reasons given in my report (2). Belot and Sgalitzer, who have tried it, have abandoned it. Belot (1935) expressed strong doubt that the small doses absorbed at the level of the granulomatous foci are sufficient to destroy the affected tissues. Experience has taught him that, in order to obtain a result, the sessions must be repeated and the total dose, in the majority of cases, must be large enough to jeopardize the general condition of the patient and the blood formula. While irradiating large mediastinal tumors, Pontus and Pianté observed an improvement in general condition, but the local effect was mediocre, however, on subjecting the mediastinum to classic segmental roentgen therapy, they saw the tumors melt.

On the contrary, Marchal, Mallet, Cottenot, and Lemoine, who irradiated cases of leukemia and of Hodgkin's disease, declared in 1934 that their former optimism in respect of the leukemias had moderated, while in granulomatosis their results were distinctly superior to those of the previous year. They have treated 18 cases during different phases of the disease, and they report that half of the cases are in a state of apparent cure, but only five of these nine cases were treated with total teleroentgentherapy alone, all the others had also received local roentgen therapy, thus, however, falls within the conception of the authors. In view of the small number of cases, the short period of observation, the contradictory results of other authors, I can only record the facts and wait until the partisans of the method are in position to report results comparable with those of segmental roentgen therapy which, in granulomatosis, has proved its worth.

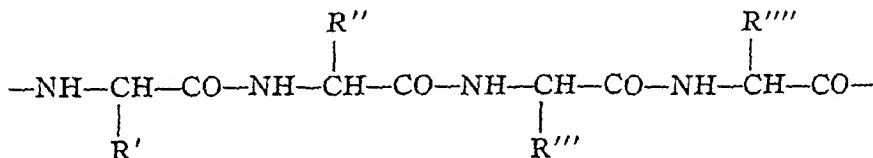
I have alluded to another method of irradiating the entire body; that of Sluys. This consists in irradiating in succession

Mack⁴ has proposed the most comprehensive theory of these differences and of the mechanism of elastic stretching, called a hydrogen evaporation-condensation mechanism. Of all synthetic rubber specimens, only chloroprene has yielded a fiber diffraction pattern upon stretching similar, but not identical with, that of rubber.

IV Proteins—Since the beginning of this century and as a result of the work of Emil Fischer and others, proteins have been considered to be long chains formed from repeat condensations of α -amino acid ($\text{NH}_2\text{—CH—COOH}$) to a configuration of



the type



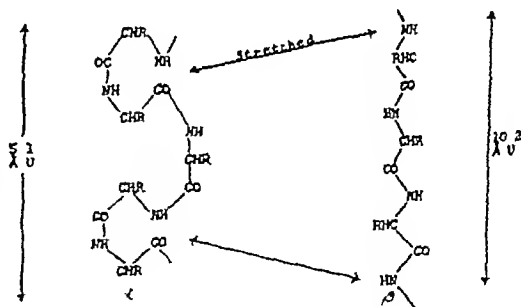
Thus a more or less common backbone is characteristic of all fibrous protein molecules and differences arise from the nature of the side-chains or R groups.

Silk Fibroin—Silk fibroin, a natural crystal fiber, is distinguished by stability and simplicity since it yields, on hydrolysis, principally glycine and alanine. Thus its R groups are only hydrogen and CH_3 . The x-ray pattern is fully consistent with the above concept of a fully extended polypeptide chain (Fig. 5). The unit monoclinic cell has the dimensions

- $a = 9.68$
- $b = 7.00$ (2 amino-acid residues of 3.5 \AA U)
- $c = 8.80$
- $\beta = 75^\circ 51'$

Stretching has no effect on the pattern, hence, the crystallites being already stretched to the fullest extent, merely slide over one another.

Keratin (Mammalian Hair)—To Astbury is due the present extensive knowledge of keratin, or the protein of hair, wool, horn, etc. When stretched, these produce patterns of β -keratin similar to silk fibroin, but in the normal unstretched state, a completely different pattern for α -keratin indicates some regularly folded condition of the backbone of the molecule from which it may be pulled out straight in the presence of moisture and to which it returns upon release of tension (Fig. 6). Thus the molecular configurations of the normal and stretched hair may be represented as follows (see figure below).



The β -keratin then forms a grid, built up by interactions and combinations between the R groups of neighboring main chains. The crystal particle consists of a series of parallel grids. The dimensions roughly are

Amino-acid residue along main-chain	
3.5 Å U	
Side-chain spacing	10.0 Å U
Spacing between grids	4.5 Å U

This form may be set permanently when the hair is steamed in the stretched state, simply because cross-linkages are hydro-

⁴ Mack, Jour. Am. Chem. Soc., 1934, 56, 2257

acts in only one direction on the hematopoietic system—therefore, without compensatory reactions of the blood-forming organs—while the latter are spared by segmental irradiation. Owing to the risk of severe anemia, Aubertin (1936) justly advised great prudence in the use of panteleroentgentherapy.

The mode of action of total teleroentgentherapy remains obscure, I shall avoid discussing it. The problems which it raises exceed the scope of the conditions considered, it relates also to certain diseases of the skin, of the endocrine glands, as well as cancer. In 1936 Desplats again stressed the hypothesis of an indirect, functional or humoral action, while Teschendorf wrote of the "*Umstimmung des Körpers*"

SUMMARY

The clinical results of panteleroentgentherapy in leukemia, erythremia, and granulomatosis are contradictory and unequal from one condition to the other. At the present time, the best results are obtained in leukemia (especially in the myeloid forms), and especially in erythremia. Save in this last condition, the relatively few things which are known do not warrant,

in my opinion, the abandon of the classic method, but it would seem that total teleroentgentherapy and local, segmental, roentgen irradiation should complement and support each other. It cannot be denied that total teleroentgentherapy has proved efficacious when segmental irradiation had exhausted its effect, I have demonstrated this myself in leukemia and in one case of erythremia.

If the usefulness and opportuneness of the method are still much debated, this is because of its real danger and its uncertainty. It is essential to know the risks well and to give constant attention to the question of individual tolerance, because of its unforeseeable variations.

I should like to express a wish: it is that the papers read in this section (of the Congress) may bring us new light, not only on the method, its indications and contra-indications, but also on the interesting biologic problems which it raises.

REFERENCES

- (1) TESCHENDORF. Die Indikationen zur Bestrahlung des ganzen menschlichen Körpers mit Roentgenstrahlen. *Therapie der Gegenwart*, No 46, 1937.
- (2) GILBERT, R. Le traitement de la granulomatoze maligne, bases anatomo-cliniques, principes directeurs, résultats. *Rapport au V^e Congres International de Radiologie*, Chicago, 1937.

acid residue $\text{NaOH} = 1.1$, has the dimensions

$$a = 5.32 \text{ \AA U}$$

$$b = 6.50$$

$$c = 11.90$$

2 residues per cell

Density = 1.372

Calculated molecular weight = 170

This reaction is reversible since the original collagen pattern is regained after treatment of the alkali addition compound in a buffered solution at the iso-electric point $\text{pH } 4.78$. Addition compounds with entirely different structures and patterns are formed with KOH , LiOH , RbOH , and CsOH . The spacing 432 \AA U decreases to 408 \AA U for chromicized gut without further evidence of inter-action of the chromicizing solution with collagen.

The peculiar behavior of the 48 \AA U interferences on treatment of the fibers with hot water, alkali solution, salts, and various organic solvents led to the discovery by Clark and Schaad of a wax-like substance whose molecules are radially oriented on collagen fibrils in these wall tissues and serve both as a lubricant and as a protection against enzyme digestion of the collagen. Analysis indicates an empirical formula of $\text{C}_{14}\text{H}_{22}\text{O}_2$ or a multiple and that the compound may be related to cholesterol derivatives rather than an ordinary ester. It is evident that this substance, which is completely absent in tendon, is synthesized or adapted by the body for this very specific purpose. The power of the x-ray diffraction method in biological research is clearly indicated by this example.

Nerve—The diffraction patterns of fresh and dried medullated and non-medullated nerves are described in a paper by Schmitt, Bear, and Clark.⁷ Medullated nerves are represented by the sciatic, motor, and sensory roots of the frog and cat and by the corpus callosum of the cat, non-medullated nerves by the claw and leg nerves of the lobster and crab.

The pattern of fresh medullated nerve is

probably due entirely to oriented fluid crystals of the myelin sheath, for it can be reproduced fairly completely in preparations made by rubbing up a benzene extract of spinal cord with water. The fundamental aggregate of these fluid crystals appears to have dimensions of $4.7 \times 9.4 \times 171 \text{ \AA}$, the various lipoids being associated in a mixed crystal fashion. The c spacing lies radial and perpendicular to the long direction of the axon. This means that in thinly myelinated fibers the myelin sheath is composed of but relatively few layers of these oriented lipoids associated end to end.

With the exception of the equatorial sickles at 11.5 \AA , the patterns of dried medullated nerve can be reproduced by dried extracted lipoids. Rings with spacings characteristic of phosphatids and of cholesterol can be identified in the pattern of dried nerve. Drying disorients certain of the components of the myelin, leaving others fairly well oriented.

Heating frog sciatics causes a disorientation of the lipoids which appears to occur at or about the same temperature at which the action potential is extinguished. Higher temperatures, which cause maximal shortening, have little further effect on the x-ray patterns.

Patterns of frog sciatics treated with cyanide until the action potential was blocked departed little from the normal.

To study the structure of the axis cylinder, lobster and crab leg and claw nerves were used. These nerves have in the past been assumed to represent pure axis cylinder, containing little or no connective tissue or lipoids. This assumption has been shown to be incorrect by chemical analysis and by histologic investigation. The lipid content may be as high as from 25 to 30 per cent of that of the white matter of mammalian brain. Connective tissue is by no means negligible, there is interfibrillary connective tissue as well as fibrous material closely adherent to each fiber. There is also a sheath which appears to be comparable to the Schwann sheath. These facts greatly complicate the analysis of the axis cylinder since the proteins of the axis

INTRINSIC SPASM



Fig 1 Case 1 (*upper left*) This film shows a spastic condition of the iliac colon with a number of diverticula (early stage) The patient had used cathartic drugs habitually

Case 1 4 (*upper right*) Same patient as shown to the left Case 1 one month after course of mineral oil retention enemas The film revealed the smoothing out of the colon and disappearance of the diverticula

Case 2 (*lower left*) Painful severe spasm of colon in habitual cathartic taker phenolphthalein Cured by stopping drug and employing a course of oil enemas One arrow points to a spastic area in the splenic flexure and the lower one to a spasm in the pelvic colon

Case 3 (*lower right*) Severe spasm in habitual water enema user Relieved by employing course of oil enemas and a smooth diet

the process of life Wyckoff and Corey,¹¹ Bernal and associates,¹² and Clark and Parker have all studied this virus Bernal has found a maximum spacing of 152 Å U for the dry gel, 210 for the wet gel (hexagonal close-packed), and 300–470 for liquid preparations A second interference appears at 75–80 Å U, which has been found by the other workers also More than twenty interferences appear on some patterns Further progress will be awaited with greatest interest

Reaction of Formaldehyde on Proteins — Clark and Shenk¹³ have shown that proteins such as gelatin, egg albumin, and hemoglobin, after treatment with formaldehyde, give diffraction patterns containing two rings of amazingly great intensity, neither of which appears in the pattern of the original protein Casein zein, and fibrous proteins, *except silk fibroin*, act similarly after a brief preliminary swelling in dilute alkali The two new spacings, 3.9 Å U and 2.6 Å U, are due, respectively, to a slightly extended amino-acid residue, and to a second order of an increased backbone spacing A very powerful reaction, probably on amide nitrogens, has probably tied two adjacent chains together This remarkable effect suggests a whole series of reactions on proteins It is of significance since the formaldehyde treatment hardens plastic proteins, and is the basis of manufacturing processes

Monomolecular Films of Proteins — Langmuir, Schaeffer, and Wrinn¹⁴ have developed the method by which many proteins capable of existing in water as large spherical molecules can be spread on water surfaces giving elastic solid monomolecular films having great two-dimensional compressibility Such mono films may be transferred from a water surface onto solid surfaces, whereby counting the total number of layers may be determined and the thickness measured by optical or x-ray

methods This work has demonstrated that if films are transferred to a solid backing by pushing into the water and then pulling out the plate, one surface of the protein film is predominantly hydrophilic A careful study of all the properties of these films has led these workers to the view that the protein mono layer is a two-dimensional network held together by strong elastic springs and is not in accord with a structure consisting of polypeptide chains X-ray studies have just been undertaken in the writer's laboratory upon multiple films When a thickness exceeding ten layers is used there is quite unexpectedly distinct evidence with egg albumin from sharp interferences in several orders of a spacing of 73.3 Å U, but the characteristic 10 Å U spacing which represents the length of the side spacings, and one of about 4.5 Å U for the backbone spacing or the thickness of grids are not detected Added interest in the whole problem, which still requires much experimental work, is based upon the theory proposed by Dr D M Wrinn of a further elaboration of the folding of protein chains into a cyclol pattern This gives to a protein sheet a framework upon which may be superposed a large number of physiologically active compounds, including the carcinogens, sterols, bile acids, sex hormones, and heart poisons The cyclol pattern depends upon the assumption, namely, that amino-acids can condense by means of single, double, or triple peptide links When such a cyclol pattern is formed, all the side chains emerge from one surface whereas the other surface is free from side chains Hence, it is possible for proteins with the most diverse chemical composition to share one common surface pattern, namely, that on the surface free from side chains The extension of this concept of the use of large molecules of various types, including proteins, as templates is exceptionally promising as an interpretation of many biological mechanisms The theory is now being subjected to careful x-ray analysis

¹¹ Jour Biol Chem 1936 116, 51

¹² Nature 1936 138, 1051

¹³ RADIOLOGY 1937, 28, 357

¹⁴ Science 1937 85, 76



Fig 3 Case 7 (left) The arrows point to the multiple spasms located in the iliac colon. The appendix was retrocecal. Operation revealed that it was bound down by adhesions. No more attacks of colon spasm after appendectomy.

Case 8 (right) A pathologic appendix. The arrows point to a spasm which simulates the filling defect produced by carcinoma. A second enema smoothed out the spasm, proving that it was not of organic nature. Cured by appendectomy.

many years ago emphasized that the condition of the colon was not inflammatory in character, that the term *colitis* was a misnomer, and suggested that *colica mucosa* was the correct designation. The syndrome is notoriously difficult to treat, often exhausting our therapeutic resources. The patient deserves a thorough general examination, and all efforts must be made to convince her that she has no organic disease (75 per cent are females). Try to have her understand the true nature of the condition. Of course, avoid all cathartics. The diet should be carefully planned—high in caloric, high in vitamin content, and free from roughage, with small, frequent doses of sedatives combined with atropine. Daily oil retention enema for several weeks' time followed by agar agar. Abdominal muscle exercises, regular periods of rest and other general hygienic measures are indicated.

Proctitis, fissure ani and other rectal le-

sions may induce spasm of the colon. The therapeutic indications are obvious.

Diseases of the colon, such as carcinoma, benign lesions, polypi, ulcerative colitis, tuberculous, dysenteric, syphilitic, and other ulcerative lesions produce more or less spasm of the colon. A pathologic appendix is a frequent cause. In the establishment of the diagnosis of such lesions, the sigmoidoscope, feces analysis, and the clinical history are essential.

Extrinsic Factors Producing Spasm—Kidney stones and acute gall-bladder conditions are common causes of colon spasm. Gastric and duodenal ulcer quite often are incriminated as etiologic factors. Many cases of colon spasm occur in psychoneurotic individuals and are erroneously diagnosed as "mucous colitis."

I have a large number of films illustrating spasm induced by many pathologic conditions. In this article I present reproductions of films of patients who have

LEUKEMIA

As for leukemia, Naegeli, of Zurich, contends that if arsenical medication is combined with radiotherapy, the result is to delay the appearance of an increasing resistance to irradiation, which paralyzes further action. An investigation conducted in the services of Naegeli and Schinz seems to support this assertion.

In order to keep in reserve an agent as valuable as radiotherapy, says Naegeli, one should first employ an intensive treatment with an arsenical preparation, parenterally as well as by mouth. And once roentgen therapy has been started, one should avoid repeating it too frequently. What should be the criterion? Doubtless the condition of the blood, but the therapeutic radiologist must not allow himself to be impressed too much by a mere increase in the number of leukocytes, if the patient feels well, if his general condition is good, if he has little or no anemia, if his blood does not contain too many immature cells (especially myeloblasts), the treatment should be postponed, even when the leukocytes reach 50,000 or 100,000 per cubic millimeter. Delherm and Stuhl, as well as others of us, have made similar observations. It follows that it is easier to stop the treatment according to the behavior of the blood than it is to know at what moment the treatment should be resumed. Here, it would seem, we have a means of deferring the appearance of radioresistance and, at the same time, of extending the limits of efficacy of the classic treatment.

It was precisely the myeloses which had become refractory to treatment which impelled Teschendorf to try irradiation of the entire body at a long focal distance.

The structures which give birth to the blood corpuscles—bone marrow, lymphoid organs, reticulo-endothelial tissue—are widely scattered in the body. Hence, the idea that by simultaneous irradiation of all the pathologic foci the results of radiotherapy would be improved. However, it is noteworthy that such a distribution

of foci, by itself, does not explain the failures of segmental irradiation since, in the myeloses, irradiation of the spleen alone often yields a primary remission which is remarkable by its quality and by its duration. The intimate mode of action escapes us.

On the other hand, it may be considered as established that once a leukemic patient has become resistant to the classic method of irradiation, he may still be capable of responding favorably to teleroentgentherapy of the entire body.

I do not intend to confine myself to the physical data and to the method of utilizing panteleroentgentherapy as expounded by W. Teschendorf, by Dale, by Cottenot and Sluys, by Mallet, Marshall, Sgalitzer, Ducuing, Marques, and others, and studied from another angle by Palmieri and by the late Heublein.

I shall examine the clinical results, then the disadvantages of panteleroentgentherapy in the conditions mentioned.

The results obtained by Teschendorf in myeloses which had become refractory to treatment, led him to adopt panteleroentgentherapy as the method of choice in this variety of leukemia. His method of irradiation is as follows: (1) as a treatment of attack, (2) as a continuing treatment to maintain the improvement obtained and to prevent recurrence. He observed that, in contrast to the classic method of treatment, panteleroentgentherapy must be continued periodically (about every two weeks), otherwise the disease is prone to recur. Is life really prolonged? This does not emerge from his report (1) of 1937, although some authors have claimed that the results are shown by a better quality and a longer duration of the remissions.

In lymphoid leukemia, Cottenot and Sluys have obtained remarkable results, while Teschendorf and Sgalitzer are more reserved, the two latter prefer a combination of segmental irradiation and total teleroentgentherapy. In such cases they all recommend the greatest prudence, because very small doses (15 r) repeated within too short a time caused a startling



Fig 5 Case 13 (*upper left*) This film was secured while the patient was suffering from an attack of gall stone colic. Fill up failed to open up the spasm in this region. At operation the colon was found to be normal. No further spasm afterward.

Case 14 (*upper right*) Severe painful spasm in case of psychosis. Patient had obstinate constipation but responded well to a course of oil retention enemas.

Case 15 (*lower left*) Severe persistent spasm of cecum in case of psychosis. Tuberculosis or carcinoma was suspected. Spasm disappeared after course of mineral oil retention enemas.

Case 16 (*lower right*) The arrows point to multiple spasm in the iliac and pelvic colon. This region was tender to pressure and was the site of extrinsic pain. The patient suffered from duodenal ulcer. The spasm subsided under dietetic treatment and a course of oil retention enemas.

large, overlapping fields (one field each day), the body being divided into from four to seven ventral fields, and as many dorsal fields. It does not present the dangers of panteleroentgentherapy, and makes it possible to give, in malignant granuloma, doses of 250 r every day or every other day, or a total dose of 1,000 r per field. Until now, it has been little used in the conditions with which we are dealing. I mention it only as a matter of record.

An interesting fact, when one is dealing with a condition characterized by slight or pronounced tumefaction of lymph nodes, panteleroentgentherapy alone usually does not suffice to make them disappear—not permanently, at any rate, while segmental irradiation, with its concentration of dosage on a smaller volume of tissue and, therefore, with its direct destruction of cells, achieves this effect without any damage to the general condition of the patient.

It is easy to understand, therefore, why the advocates of panteleroentgentherapy or of total irradiation by segments should also favor local irradiation whenever total irradiation does not bring about the expected local modifications: the two methods do not exclude each other, rather, they complement each other.

In fact, nothing in panteleroentgentherapy could be more dangerous than to increase the dose given at each session or to repeat the sessions too frequently, simply because a spleen or a mass of enlarged nodes does not diminish in volume. This method requires exact dosage and extreme prudence in the rhythm of irradiation. In truth, the minimal size of the doses is only apparent, because, while the dose per unit of surface is small, the total energy absorbed is very great (this is what the German authors refer to as *Raumdosis*). Moreover, beside the question of dosage, there exists "an extremely complex series of biologic factors which, together, constitute individual tolerance" (Marchal and his co-workers). As the usual dose per session, Teschendorf mentions 6 to 15 r only, of which one-half is given to the ventral surface and the other half to the dorsal sur-

face. In myeloid leukemia the dose is repeated only after an interval of from eight to fifteen days, according to the numerical behavior of the leukocytes. In erythremia Sgalitzer begins by "test irradiations" for six consecutive days, alternately through the ventral and dorsal surfaces, with a maximal dose of $1/25$ HED, or less than 25 r (Teschendorf mentions a dose of from 5 to 7 r), this trial is followed by a blood count, not for the erythrocytes which would not have had time to diminish, but to watch the leukocytes which vary so much in different patients according to their individual susceptibility to irradiation. This fact, to which Cottent and Sluys have drawn attention, led Sgalitzer, in erythremia, to extend the cycle of irradiation over a period of four weeks (a total of from 12 to 22 sessions, with repeated blood count) when the leukocytes prove resistant while the cycle is extended over a period of two or two and a half months when the leukocytes prove too sensitive to this mode of irradiation.

This makes the dangers of the method quite obvious. Experimental investigations had led us to suspect these dangers, and during the past few years these suspicions have been confirmed. I shall consider especially the hematologic accidents observed by different authors. Except the startling but rather inconstant decreases in the number of leukocytes which have already been mentioned, analogous decreases of the erythrocytes, as well as thrombopenia with its grave complications may occasionally be observed after a certain latent period. A late and progressive anemia may sometimes correct itself or may be repaired by repeated transfusions. The fact that in 1934 Marchal and his co-workers advised immediate interruption of total irradiation when the erythrocytes fall to three millions, or when a sudden, sharp fall of the erythrocytes (for example, from 5,000,000 to 3,800,000 in one week) impresses one with the risk involved. According to Marchal and Mallet, the fall in the erythrocytes is due to the fact that total teleroentgentherapy

CLINICAL RESULTS IN SIXTY-NINE PATIENTS TREATED BY A SUBSTERILIZING DOSE OF RADIUM OR X-RAY¹

By JAMES A. CORSCADEN, M.D., HAIG KASABACH, M.D., and MAURICE LENZ,
M.D., *New York City*

From the Department of Obstetrics and Gynecology and the Department of Radiology of the
College of Physicians and Surgeons, Columbia University

INTRODUCTION

DESPITE the rapid recent advances in our knowledge of the physiology and anatomy of the sexual cycle and despite the availability of pituitary-like and ovarian substances for the treatment of menstrual disorders, there has not been the expected improvement in results following the employment of these substances in the treatment of menstrual disorders. There remain and are likely to remain a number of patients who will require radical therapy by various destructive methods among which radium and x-ray will be of importance. While in about fifteen hundred patients it has been relatively easy to produce a permanent menopause (98 per cent), an attempt to modify or interrupt menstruation without terminating it has been followed by varying results. Those from the standpoint of loss of blood have been generally satisfactory but there has been a wide range of dosage, considerable variation in the duration of amenorrhea following the same doses, and in some an undesired permanent menopause.

Obviously the logical therapy for any disturbed function should aim at the restoration of that function and every device available should be employed to that end. Only if the loss of blood or menstrual distress be great enough to cause definite incapacity should one direct his efforts in the opposite direction and destroy partly or completely one of the three structures essential to menstruation, pituitary, ovarian follicles, or endometrium. We have had little experience with radiation of the pituitary gland or destruction of the endometrium by powerful caustics. It has been

necessary in a few cases to remove a normal uterus. Our present study is based on the principle that radium and x-ray destroy ripe Graafian follicles and is directed toward the establishment of an effective yet substerilizing dose.

Radium has been given in the endometrial cavity in doses of from 25 milligrams for 12 hours to 100 milligrams for 24 hours with a filtration of 0.5 mm silver, 0.5 mm platinum, or 1.0 mm platinum with 1.0 mm rubber secondary filter. The filtration has made some difference in the dosage. To produce a permanent menopause with reasonable certainty, a dose of 1,800 milligram-hours has sufficed with 0.5 mm platinum. With 1.0 mm platinum, however, a dose of 1,800 milligram-hours was followed by an increasing number of recurrences of bleeding, 2,000 to 2,400 milligram-hours seems to be necessary. X-ray up to 1923 was given through six abdominal, two lateral, and one posterior portal 3×3 cm with 100 kv, 25 cm anode-skin distance, and from 3 to 5 mm of aluminum filter. This will be designated "old x-ray." After 1923 it was administered through one anterior and one posterior field, 10×15 cm, with 180-200 kv, 50 to 80 cm anode-skin distance, 0.5 mm Cu and 1.0 mm Al filter. Dosages with the "old x-ray" are expressed in total milliamperes-minutes. In the average woman of 40, three series of nine exposures of 45 milliamperes-minutes each almost always caused amenorrhea. Calculated in roentgens, the total skin dose corresponded to about 800 r, giving an approximate ovarian dose of 250 r. With modern technique the doses are expressed in international roentgens without back-scattering. Depth doses are not given. Variations in the location of the ovaries, where observed, have been

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COLON SPASM

By HORACE W SOPER, M D , St Louis, Mo

THE clinical significance of spasm of the colon has not as yet been clearly established. The spastic colon and its relationship to constipation is generally recognized. Errors in diagnosis are frequently made in spasm that involves a segment of the colon.

The roentgenologist often experiences great difficulty in the interpretation of films that show localized spasm, because many such films simulate carcinoma, stricture, and other organic lesions. His efforts to remove the spasm by the administration of drugs such as atropine, benzadrine, etc., are usually futile and disappointing.

Our roentgenologist, Dr Jacob Leptich, has devised an effective and simple method for differentiating spasm from an organic lesion. When a suspicious filling defect is discovered, the patient expels the enema and a second enema is given which now removes the spasm and results in a smooth film. If persistent after the second enema, the lesion is diagnosed as being of organic nature. The method also has been found to be effective in correcting spasm of the pylorus and duodenum. After the barium meal has left the stomach a second "fill up" reveals a smooth outline instead of the ragged, irregular, spasmodic condition. The irradiated barium meal appears to be an efficient agent in temporarily eradicating gastro-intestinal spasm. The employment of water enemas prior to the examination is bad practice inasmuch as they tend to induce spasm and distortion of the colon. Fecal masses are surrounded by the barium mixture and do not interfere with the diagnostic function of the enema, therefore, the preliminary "cleansing enema" is not only unnecessary but is likely to produce abnormal conditions that cloud the diagnostic picture.

Spasm of the entire colon probably never occurs, at least I have not seen it. *Pr-*

mary essential uncomplicated spasm usually involves the descending iliac, and pelvic colon and occurs as a rule in patients of hypersthenic or sthenic habitus, rarely in one of the asthenic habitus. It is usually associated with spasm of the anal sphincter musculature. This condition is described by Hurst as *dyschezia*. The ampulla recti and the cecum are frequently dilated and hypotonic in character. The patient is constipated, and purgatives and enemas cause cramp-like pains in the left abdomen and are ineffective. The feces consist of small, marble-like masses. The iliac colon is palpable as a painful, persistent cord, not the intermittent spasm observed in the normal colon.

The principles of treatment are as follows:

- 1 Smooth, high calorie, high vitamin diet

- 2 Administration of agar-agar or mineral oil, and in severe cases the oil retention enema

- 3 Intermittent dilatation of the anal sphincter, and in severe spasm of the recto-sigmoid region, treatment by local applications of magnesium sulphate solution as I have elsewhere detailed

Psychic spasm occurs in patients suffering from the psychoses. It is usually initiated as an acute attack producing severe abdominal pain and obstinate constipation. Treatment consists in large, frequent, mineral oil retention enemas and the administration of sedative drugs combined with atropine.

Psycho-neurotic spasm is encountered in individuals of unstable nervous system. It occurs in attacks of left-sided abdominal pain accompanied by the expulsion of large strings of mucus. The tough, clear masses sometimes form a cast of the lumen of the gut, this condition usually being termed *mucous colitis*. Ewald and Boas

and irregular for another two years (17 years)

Case 4 R S, age 25 Para one One year menorrhagia Chronic pelvic inflammatory disease Radium, 700 mgm-hr No reaction Periods infrequent but prolonged Pain unrelieved Hysterectomy for pain two years after original treatment

Case 5 G R, age 16 Para 0 Metrorrhagia two years "Old x-ray," 760 ma-min Periods remained irregular, slightly profuse Radium, 600 mgm-hr, six months after original x-ray Periods regular, with occasional skipping, for two years Bleeding recurred Dilatation and curettage Periods regular, somewhat profuse for four years (six years)

Case 6 A J, age 19 Para 0 Two years menorrhagia, metrorrhagia "Old x-ray," 850 ma-min Bleeding stopped immediately returned after nine months, regular for three months No further observation

Case 7 H S, age 19 Para 0 Four years metrorrhagia "Old x-ray," 300 ma-min Continued profuse Three months later, 450 ma-min Continued profuse for another four months 150 ma-min Skipped nine months One profuse period Dilatation and curettage Normal for seven years then profuse for one year Hysterectomy for myoma 12 years after first x-ray

Case 8 E K, age 21 Para 0 Purpura hemorrhagica Two years menorrhagia "Old x-ray," 500 ma-min Bleeding stopped immediately Two periods in a year, thereafter none Died two years after treatment

Case 9 K M, age 22 Para one Two years menorrhagia and metrorrhagia "Old x-ray" 1,200 ma-min Bleeding stopped after three months Returned after 13 months, regular, excessive Radium, 600 mgm-hr, 19 months after original x-ray Permanent amenorrhea for 22 years

Case 10 R R, age 24 Para 0 One year metrorrhagia "Old x-ray," 280 ma-min Periods continued every 14 to

16 days, somewhat profuse and painful Followed three years

Case 11 L G, age 25 Para 4 Prolonged menorrhagia "Old x-ray," 1,050 ma-min Periods normal One year after treatment full term pregnancy child died at six months Two years after treatment abortion at two months Eleven years after treatment spontaneous delivery of normal child

Case 12 B K, age 25 Para 0 Fifteen months metrorrhagia "Old x-ray," 1,435 ma-min Periods normal for seven years, then profuse 200 ma-min Periods scant and irregular Followed 13 years

Case 13 J W, age 15 Para 0 Three years menorrhagia, metrorrhagia 300 r anterior and 300 r posterior Stopped after three months, returned after 13 months Became profuse two years after first treatment 300 r anterior and 300 r posterior One period Amenorrhea for two years

Case 14 J C, age 21 Para 0 Osteomalacia 400 r anterior, 200 r posterior, six weeks later 400 r anterior and 400 r posterior One period five years after treatment

Case 15 B C, age 24 Para 0 Four years menorrhagia, metrorrhagia 150 r anterior and 150 r posterior Periods normal for one year

There were 43 women between 25 and 40 years of age Table II indicates the immediate results of the various dosages in these women and demonstrates the inconstancy of the results Note that one woman, receiving 600 mgm-hr of radium, stopped menstruating after three months and remained permanently amenorrheic (ten years), while 19 who received from 1,200 to 1,800 mgm-hr required either hysterectomy or x-ray to control continued or recurrent bleeding Similarly, of the five women who received 150 r anteriorly and posteriorly by modern technique, one was permanently amenorrheic One of nine patients receiving a total of 600 r was permanently amenorrheic, as was one patient receiving 700 r

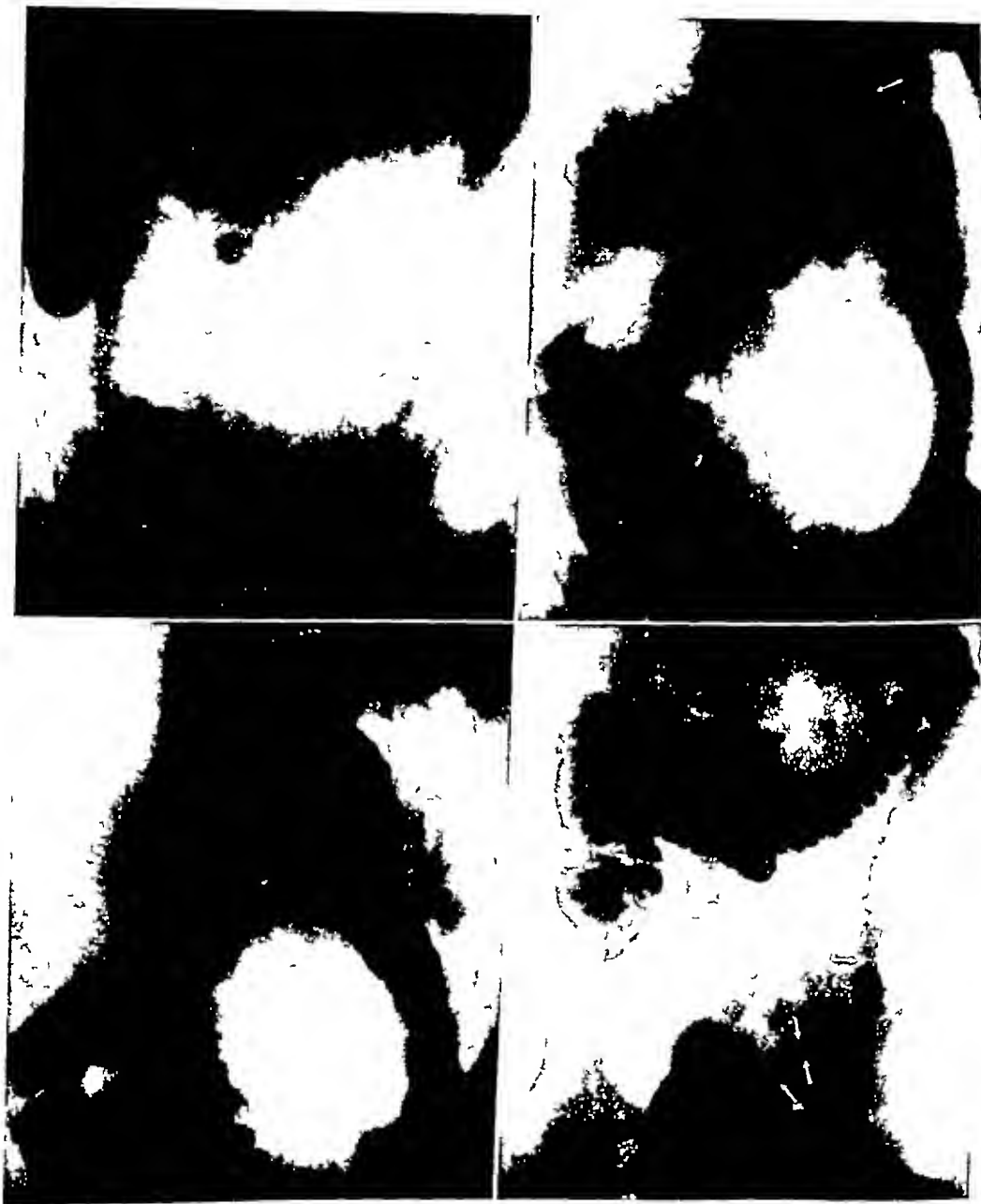


Fig 2 Case 4 (*upper left*) Painful spasm in cathartic taker (phenolphthalein) Relieved by stopping drug and giving course of oil enemas Descending and iliac colon are usual locations for intrinsic spasm

Case 5 (*upper right*) Case of ulcerative colitis in an abnormal colon The arrow points to a narrow portion of the colon raising the question of organic stricture

Case 5-A (*lower left*) The second fill up enema removed the filling defect thereby proving that it was not an organic stricture but a localized spasm

Case 6 (*lower right*) The arrows point to multiple spasms in the iliac colon due to a pathologic appendix The pain and tenderness was persistent in this region no pain present in the region of the appendix Appendectomy resulted in complete disappearance of the symptoms

Late results in these women showed one who continued to be normal for one year, three for four years, three for six years, and one for twenty-four years. Scant and irregular bleeding persisted in three women for four years, in three for eight years, and in one for twelve years. Hysterectomy was performed on six patients, two for continued bleeding from a normal uterus, one for continued bleeding with a large fibroid, two because patients with small fibroids preferred hysterectomy to a permanent menopause, and one because of a misinterpretation of the nature of scant bleeding (fear of carcinoma which did not exist). Thirteen women were retreated by x-ray or radium, all became amenorrheic and so remained for two years, six years (three cases), and eight years (three cases), leaving four whose treatment has been too recent for purposes of a late observation.

The 11 patients in Table III over 40 years of age are selected merely to bring out the fact again that small doses of radiation terminated menstruation in some, whereas larger doses failed in others. With efficient methods for controlling distressing menopause symptoms in the occasional case, we can see little reason for a partial dose in women of this age.

The conclusion from these observations is that the substerilizing dose cannot be satisfactorily expressed numerically. If menstruation must be preserved, small initial doses (150 r, 25 per cent ESD to one anterior and one posterior field) must be given. Radium is seldom employed for the reasons given later.

DYSMENORRHEA

Dysmenorrhea was a major symptom in nine patients. In two cases the menstrual distress was an exacerbation of a chronic inflammatory symptom and was slightly relieved by a temporary menopause. One patient, aged 31, was operated upon for endometriosis and retained one ovary. The recurrent dysmenorrhea was treated by x-ray. For six years menstruation has been infrequent and usually somewhat painful.

Amenorrhea between the periods has been accompanied by hot flashes. We believe that a permanent menopause would be more satisfactory. However, this assurance that endometriosis can be terminated by sterilization permits us to leave untouched the uninvolved ovary in these cases in the hope that future child-bearing may be possible.

The fourth case of dysmenorrhea followed excision of an ovarian cyst in a woman of 26. Terrific attacks of pain and vomiting preceded each irregular triweekly period. Exploratory laparotomy, abandoned because of adhesions, left her with a fecal fistula which healed spontaneously. After radiation, menstruation and the attacks ceased. Eight months later a typical attack of pain was followed by a period. Permanent amenorrhea was established by further x-ray and radium. Since then there has been perfect health marred only by occasional hot flashes which required no treatment (eight years). The fifth case of dysmenorrhea persisted in a woman despite resection of large polycystic ovaries. During the temporary menopause the pain ceased but returned with menstruation and was terminated by further radiotherapy. Incidentally the enlarged ovaries became atrophic. The sixth patient, aged 27, was obese. The pelvic examination was normal. Vomiting and pain were so disabling as to endanger her position as an executive. Following radiation she was amenorrheic for eight months and free from pain. Her obesity disappeared. With the return of menstruation the distress also returned and she again became obese. She refused a permanent menopause and has been greatly relieved by psychoanalysis. The other three patients (33 1/3 per cent), with apparently normal pelvic organs, remained completely free of pain after the return of their periods.

FIBROMYOMA

Among the women between the ages of 25 and 40 there were six cases of fibro-

EXTRINSIC FACTORS

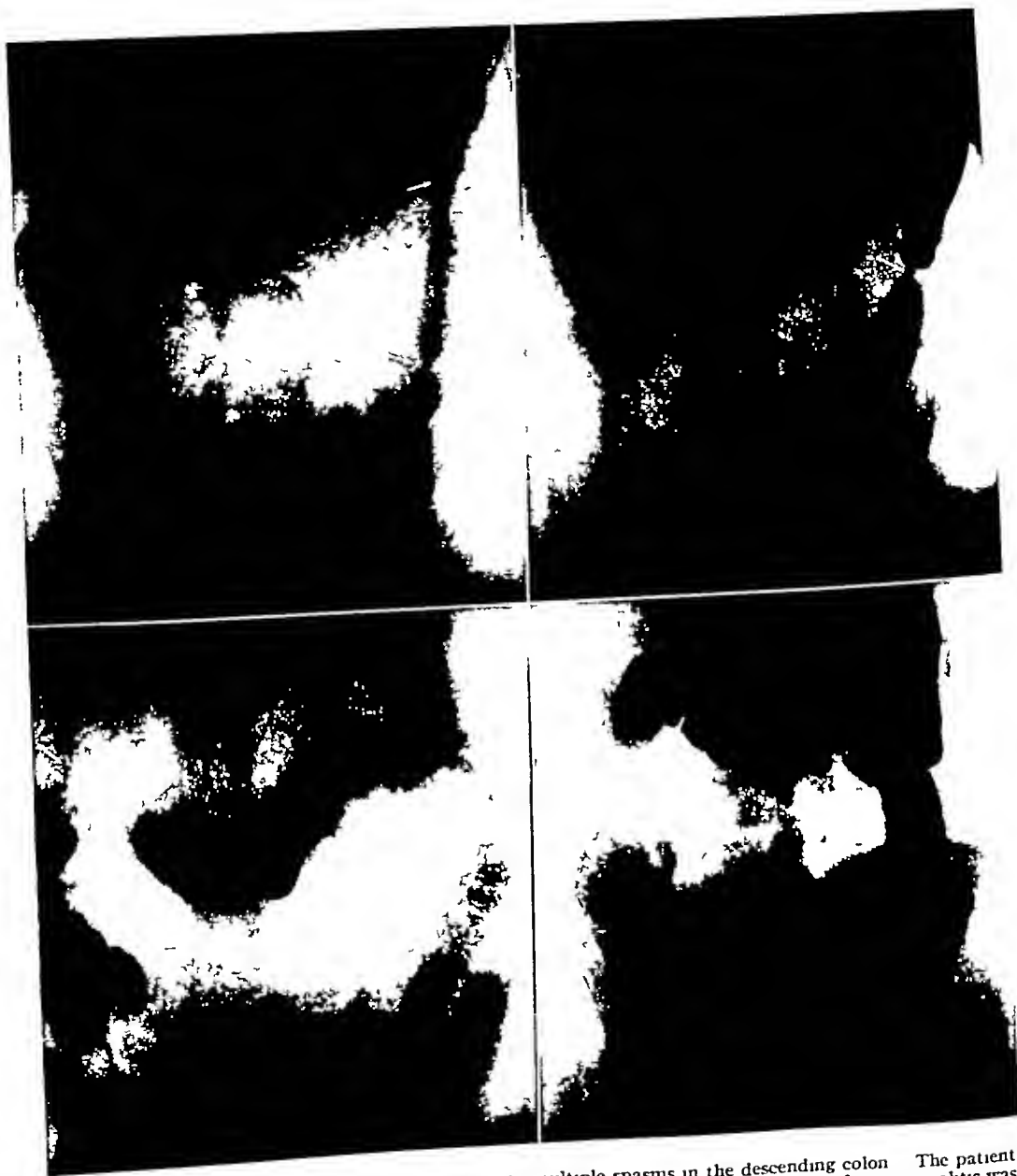


Fig 4 Case 9 (upper left) The arrows point to multiple spasms in the descending colon. The patient had severe pain in this region with expulsion of large masses of mucus. The diagnosis of mucous colitis was made. The urine revealed the presence of red blood cells and a stone was found embedded in the kidney parenchyma. Removal of the stone completely cured the mucous colitis.

Case 10 (upper right) The arrow points to a spasm which one might easily believe to be of organic nature. The kidney serial revealed the presence of a kidney stone that was producing no blocking. Spasm disappeared after operation.

Case 11 (lower left) The arrows point to a filling defect at the hepatic flexure. The patient had a fourth degree displacement of the kidney. The operation of kidney fixation revealed that the colon was normal. Following operation a course of oil enemas was given which removed any further colon spasm.

Case 12 (lower right) The arrow points to a spasm of the cecum which simulates a filling defect ordinarily seen in carcinoma. Pain was persistent in this region. The patient was operated upon for gallstones and exploration of the colon showed no organic disease.

tended to the umbilicus. Hysterectomy was abandoned because of adhesions. She received 600 r and was amenorrheic for eight months. The mass shrank to the size of a three-months' pregnancy and then began to grow, reaching its original size in two years, when the periods returned. Following additional x-ray, she again became amenorrheic. The mass is somewhat smaller in size (six months later).

To summarize, the substerilizing dose for myomas has not been satisfactory. In only two patients did the periods continue and the mass shrink. The others either became amenorrheic after a small dose, required supplementary radiotherapy to control bleeding and the size of the mass, or were operated upon.

PREGNANCY

Six women have become pregnant. Four have been reported in part (Murphy, 1929) but are included for the sake of completeness. One woman, aged 36, with a fibromyoma the size of a three-months' pregnancy received 1,200 mgm-hr of radium. The periods were regular for 18 months. She became pregnant, had a miscarriage at four months, followed by slight puerperal fever. The fetus was grossly normal. No follow-up. A patient, aged 25, was given 700 mgm-hr of radium for primary metrorrhagia. The periods became infrequent and somewhat scant. A pregnancy nine years after treatment, aborted at six weeks, and another occurring 15 years after treatment, aborted at eight weeks. She was curetted each time without complications. A patient, aged 28, received 600 mgm-hr of radium after which the periods became normal. She became pregnant four years after treatment, and aborted. Her second pregnancy, one year later, was normal and the child was normal. A patient, aged 25 received a total of 1,050 ma-min of the "old x-ray," after which her periods became normal. The first pregnancy, one year after treatment, was normal. The child was normal but died at the age of six months of unknown

cause. The second pregnancy, two years after treatment, was aborted spontaneously at two months. The third pregnancy, eleven years after treatment, resulted in the normal delivery of a normal child who has showed abnormal behavior, requiring institutional care at the age of nine. There is ample cause in the heredity and environment, however, adequately to account for this. A patient, aged 28, received 532 ma-min of "old x-ray," after which her periods became normal. Pregnancies, four and ten years after treatment produced normal children, now 16 and 12 years old, respectively, in perfect health and in advanced grades in school. A patient, aged 30, given 500 mgm-hr of radium for primary menorrhagia, became pregnant ten years after treatment. By Cæsarean section a slightly premature, otherwise normal, child was born, but died, aged six weeks, of epidemic enteritis.

A summary of these few cases showed that of 11 pregnancies only four children have lived beyond infancy, five having aborted and two dying at six weeks and six months, respectively. If these proportions existed in a series large enough to make the figures valid, it would appear that radiotherapy exerted a harmful influence on subsequent pregnancies. Fortunately the larger collections of cases do not seem to bear this out (Murphy, 1929, Miller, 1936, Kraemer, 1930).

CHOICE OF PROCEDURE

The management of a young woman suffering from a menstrual disorder without gross pelvic lesions is conducted about as follows:

After a complete diagnostic study, attempts are made to establish a normal physical and mental hygiene, anterior pituitary-like substances and or Progesterone will be given, occasionally rationally, more often empirically. At some point in the procedure, not always at the beginning, a curettage will usually be performed. Often this will control the bleeding for several months. If it does so for from six to eight months, it is frequently wise to re-



Fig 6 Case 17 Persistent, painful spasm in case of gastric ulcer The arrow points to severe spasm of the descending colon which might easily be mistaken for stricture or carcinoma This area of the colon was extremely sensitive to palpation and localization of severe attacks of pain Under dietetic treatment and a course of oil enemas the spasm was entirely relieved

been kept under observation after operation or after the employment of treatment The follow-up disclosed no recurrence of the former symptoms For example

Case 2 had daily attacks of intermittent cramp-like pains of six months' duration

In Case 5 it was very important to determine whether the defect in the colon was a spasm or an organic stricture.

In Case 6 the attacks of pains were located in the region of the iliac colon and not in the appendix region (four months' duration)

The film of Case 15 was secured before we had known of the second barium enema procedure to abolish spasm (The appendix had been removed) The patient complained of severe intermittent pain in the right lower quadrant, and obstinate constipation of two months' duration He was scheduled for operation when I saw him in consultation The absence of blood, pus, and tubercle bacilli in the feces caused me to advise postponement and treatment After the spasm had subsided there was no recurrence of the subjective symptoms

the endometrium to be affected by the radium (Corscaden, 1935). Secondly, the absence of menstruation, either temporary or permanent, was almost always accompanied by hot flashes. Thirdly, examinations of the blood and urine of women made amenorrheic by radium or x-ray have shown the characteristics found in the spontaneous menopause—absence of estrone and increase of prolactin. We accept the principle, then, that while radium, by its local action, may destroy part of the endometrium and may, for a cycle or two, modify menstruation thereby, the essential action of radium and x-ray is upon Graafian follicles in any prolonged modification of the sexual cycle.

Of the two agents radium or x-ray, we most often employ the latter. If pregnancy occurs later on in life, the uninjured uterine cavity will be more likely to retain the ovum. Secondly, control of dosage is more difficult with radium, because the intensity of the irradiation is reduced in inverse proportion as the square of the distance from the radium. The difference of a centimeter or two in the distance between the radium in the uterus and an ovary may make a difference of as much as 50 per cent in the amount of radiation reaching the follicles. On the other hand, in a case in which a patient is suffering from an extremely profuse hemorrhage, the good effects of a dilatation and curettage and insertion of radium are almost always immediate because of the local caustic effect of the radium. Only in these cases is radium preferred.

In the literature there is a fair unanimity of opinion that in a young woman a dose of from 23 to 29 per cent E S D will be fol-

lowed by a definite and temporary amenorrhea (C. J. Gauss, 1930), (Kadisch, 1921, 1925). Schneider (1930), varying the dose according to age, constitution, and indication, can produce an amenorrhea of predictable duration. Our experience does not confirm this. The inconstancy of the radium results may be explained on mechanical grounds. Any ovarian tissue lying at a distance from the uterus would receive an ineffectual dose of radiation. Variations in the results from x-ray are more difficult to explain (*cf* C. J. Gauss and Wintz, 1930). If a reasonable guarantee must be given that menstruation will return, an initial dose of 150 r anteriorly and 150 r posteriorly, given in two sittings, is safe. If the woman is nearing 40, an even smaller initial dose may be needed. If, because of the severity of the symptoms, a more certain effect is desired and the risk of a permanent amenorrhea not so objectionable, one would be justified in giving an initial dose of 300 r anteriorly and 300 r posteriorly in four treatments. Except for acute bleeding, radium should not be employed.

REFERENCES

- CORSCADEN *Am Jour Roentgenol and Rad Ther* 1935, 33, 810
 GAUSS, C. J. *Verhandl d deutsch Ges f Gyn*, 1911, 14, 422
 Idem *Strahlentherapie* 1930, 37, 511
 KADISCH *Inaug diss* 1921
 Idem *Strahlentherapie*, 1925 19, 462
 KRAEVEK *Inaug diss Wurzburg* 1930
 KRETZSCHMAR and GARDINER *Am Jour Obst and Gynec*, 1935 29, 168
 MILLER, CORSCADEN, and HARRAR *Am Jour Obst. and Gynec* 1936 31, 518
 MURPHY and GOLDSTEIN *Am Jour Roentgenol and Rad Ther* 1929 22, 207 and 322
 Idem *Surg, Gynec and Obst*, 1930, 50, 79
 SCHNEIDER *Arch f Gynäk* 1931 144, 567
 WINTZ *Strahlentherapie* 1930 37, 407

TABLE I — IMMEDIATE RESULTS
Ages 15 to 25 years (See note on Table III, p. 208)

Dose	Continued to Flow			Subsequent Treatment Required			*Bleeding Stopped after (Months)				Permanent Menopause	*Bleeding Returned after (Months)						Character of Return Flow		Subsequent Treatment	
	Normal	Scant Irregular	Profuse	X ray	Radium	Hyster-ectomy	1	2	3	4		4	8	12	24	60	Normal	Scant, Irregular	Profuse	X ray	Radium
Mgm hr of Radium																					
625	2				1					1							1				
700			1			1	1							1							
Old x ray"	2		2		1	1	2	1						3			1	1		1	
Modern x ray	1																				
300 r																					
600 r																					
1400 r							1	1						1			1			1	

so great that the depth dose to the ovary seems to be of very small importance in comparison with the other variables. This unreliability may be illustrated by two cases. A woman of 36 with a myoma the size of a three months' pregnancy and an abdomen measuring 18 cm anteroposteriorly was given 300 r anteriorly and posteriorly. Because of continued bleeding the same dose was again necessary four months later. Only after two years was amenorrhea complete. Another woman, of 26, with a uterus of the same dimensions and an anteroposterior dimension of 20 cm was given 240 r anteriorly and posteriorly. She stopped menstruating after one period, menstruated again after 13 months, and has been amenorrheic for two years. With identical x-ray factors a relatively large dose of x-ray given to an older, thin woman produced less effect than a small dose in the younger fat patient.

This study includes all of the cases in which an attempt was made to alter, but not terminate, menstruation and some cases in which the induction of a permanent menopause was intended but not accomplished by the initial dosage. It was hoped that from this material it might be possible to establish a "safe substerilizing dose" (Tables I, II, and III).

There were 15 patients between the ages of 15 and 25 (Table I). Brief summaries of the cases are given.

Case 1 G D, age 22 Para one. One year menorrhagia. Radium, 625 mgm-hr. Menstruation regular for one year.

Case 2 E C, age 23 Para one. Two years menorrhagia. Radium, 625 mgm-hr. Bleeding stopped immediately. Returned after four months. Regular for 17 years.

Case 3 R P, age 25 Para 0. Three years menorrhagia. Radium, 700 mgm-hr. Bleeding stopped after one month. Returned after 13 months, infrequent, scant. Nine years after treatment, abortion at six weeks, again, 15 years after treatment, at eight weeks. Periods scant.

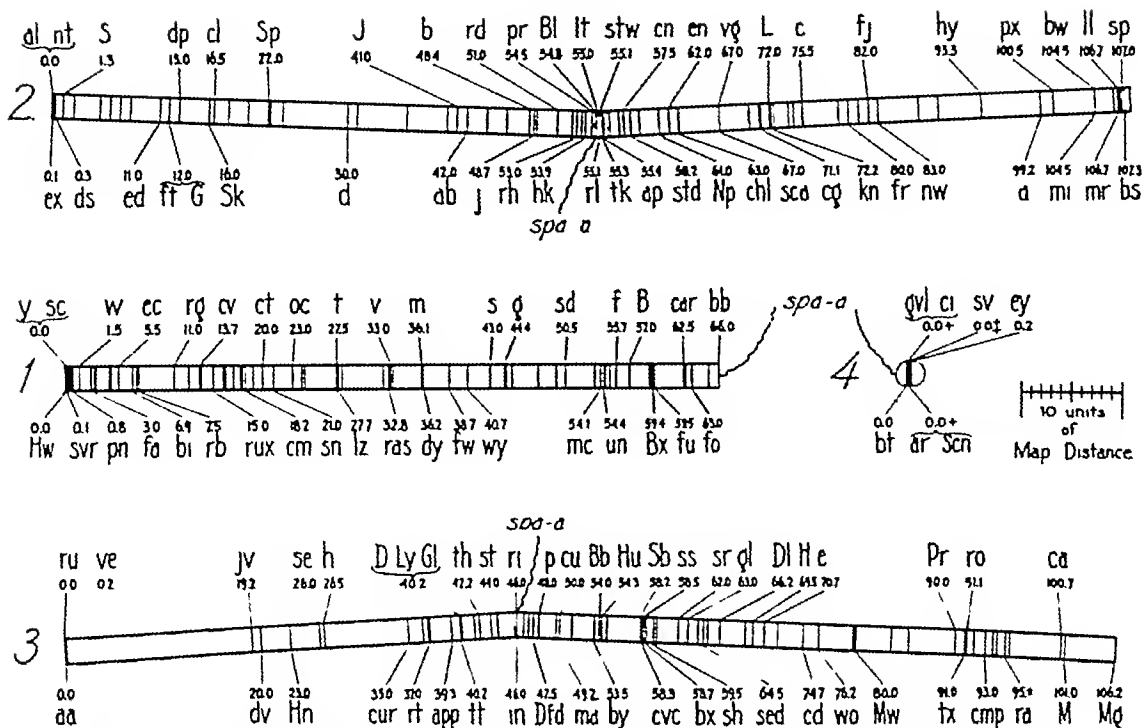


Fig 3 Genetic maps for the four chromosomes of *Drosophila melanogaster* (C B Bridges)

come clearly defined (Fig 2-A) In most organisms they condense to form sausage-shaped bodies (Fig 2-B) These chromosomes then become arranged in the center of the cell (Fig 2-C), where each is seen distinctly to be split longitudinally (Fig 2-D) Subsequently one half of each chromosome moves to one pole, the other half, to the opposite pole of the cell (Fig 2-E) Around each of the two groups of chromosomes a new nucleus is organized, the formation of a cell wall traversing the cytoplasm between the two nuclei completes the division (Fig 2-F)

To the geneticist chromosomes are the most important constituents of a cell because they are carriers of hereditary units known as genes Genes possess a unique capacity of self-reproduction which is one of the most important characteristics of living matter All evidence indicates that they reproduce exactly and moreover, that if any change occurs the gene reproduces in its changed form Experimental evidence suggests that genes possess a high degree of stability It is known that changes in genes do occur spontaneously

but, as a rule, the frequency of such changes is very low It is known, also, that genes are very resistant to the influence of ordinary environmental fluctuations So far the only agents known to induce gene changes with certainty are x-rays and related radiation High temperature also induces such changes, but, the effective range being high, is too injurious to the organism to be of extensive practical use

Since genes are ultramicroscopic, our knowledge about them must be obtained through indirect methods It is estimated that every cell of the "vinegar fly" (*Drosophila melanogaster*) has about 5,000 different genes Some of them, a small proportion, can be recognized by the effect they produce on the organism and thus can be studied by breeding methods These studies show that every gene has a fixed location in a chromosome The location of the genes which produce these visible effects can be determined and thus the so-called "genetic maps" can be constructed Figure 3 shows such maps for *Drosophila melanogaster*

TABLE II—IMMEDIATE RESULTS

Ages 26 to 40 years

Dose	Continued to Flow		Subsequent Treatment Required		*Bleeding Stopped after (Months)				Permanent Menopause	*Bleeding Returned after (Months)					Character of Return Flow		Subsequent Treatment		
	Normal	Scant Irregular	X ray	Radium	Hyster-ectomy	1	2	3		4	4	8	12	24	60	Normal	Scant, Irregular	X ray	Radium
Mgm hr of Radium																			
375		1	1	1	1														
400						2					2				2				
450						1						1				1			
550								1									1		
600	2		1	1				2		1	1								
900	1																		
1100		1		1															
1125	1			1															
1200	2	1		1						x									
1400						1				x							1		
1500								1		x									
1800	2	1								x	1					1			
2400						2				x	1		1			1			
								1		x	1					1			
Old x ray	1	1	1			1		1				1	1			1			
Modern x ray																	2		
300 r						3	2			1		1	2	1		3	1		
480 r								1											
600 r	3	1	1	1		3	2			2									
1200 r						1	1			x		1		1		1		1	
1500 r						1				x			1			1			

* See note on Table III (p. 208)

GENETIC RESULTS

For an analysis of hereditary changes, breeding methods are more sensitive than

cerned because the breeding of this species offers certain unique advantages. It is not surprising, therefore, that a great deal of

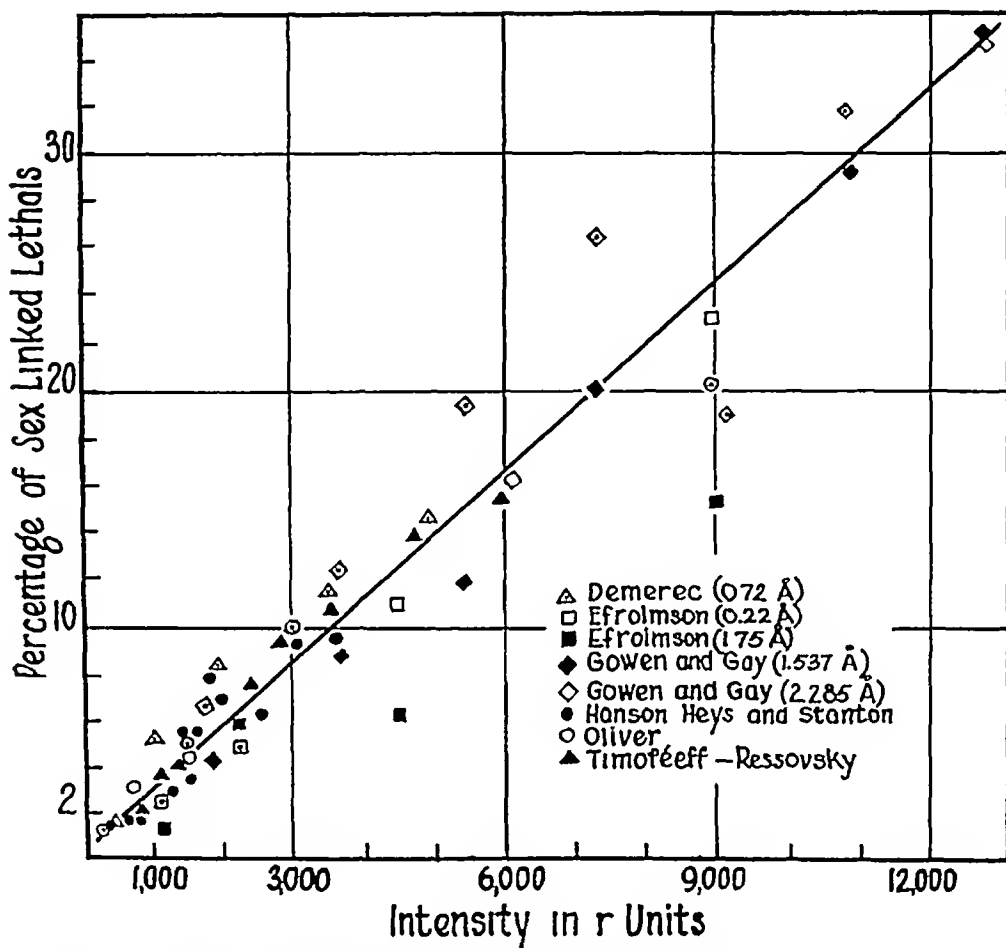


Fig. 5 Percentage of lethals in the X-chromosome of *Drosophila melanogaster* in relation to the intensity of radiation (From Schultz, 1936)

cytological methods. By breeding methods, however, only those changes can be detected which show up in the offspring. This limits the applicability of the method to the group of hereditary changes which are not too large to be injurious, nor too small to be undetectable. In analyzing the results of numerous experiments in which x-rays were used, it is well to keep in mind that only an unknown fraction of the changes actually induced has been registered in these results.

Drosophila melanogaster is the best known organism as far as heredity is con-

our knowledge concerning the hereditary effects of x-rays has been derived from studies made on these flies. In this report the results obtained in work with *Drosophila* will be used to a large extent.

It has been found that x-rays can influence hereditary traits by producing breakages in chromosomes and also by inducing changes in genes. Evidence is available which indicates that, very frequently, at the point of a chromosome break, a change in a gene also occurs. Since, in a large proportion of cases, these changes represent either an inactivation or

tation rate Apparently there is no evidence of recovery in the case of hereditary effects As long as the same cells are treated, the effect is similar irrespective of whether the increase in dosage is accomplished through a longer continuous or fractionated treatment

Another important contribution to the problem of x-ray action came from experiments by Muller (1928) and by Harris (1929), who showed that the frequency of lethal mutations was similar in the sperm used immediately after irradiation and in the sperm tested several days after the treatment

All these facts, namely, the independence of the frequency of changes from wave length, the direct proportionality between dosage and the frequency of changes, absence of delayed effect, and results with fractional treatment suggest that changes in genes are produced directly by electron hits This hypothesis has been elaborated in detail by Timofeeff-Ressovsky, Zimmer, and Delbruck (1935)

However, the results of recent experiments brought out new facts which are not in agreement with the direct hit hypothesis Dubovskij (1935) reported that several *Drosophila* lines differed significantly in the frequency of lethals induced by a similar treatment I have observed that the Oregon-R stock of *Drosophila melanogaster* has a significantly lower rate of induced mutations than all other wild-type stocks tested so far In Table I and Figure 6 results of

experiments are shown in which Swedish-b and Oregon-R stocks were given a simultaneous treatment with certain x-ray dosages It is evident from these results that in every instance the Oregon-R stock had a lower rate of mutation than the Swedish-b stock Since in these experiments all external factors were identical for every dosage used, the differences observed can be attributed only to the differences in biological factors To explain these results by the direct hit hypothesis it is necessary to make several assumptions which are not needed if it is assumed that the action of x-rays on the heredity-bearing material is indirect The changes in genes and chromosomes are probably of the nature of sensitized reactions induced by the transfer of energy from neighboring activated molecules (Fricke and Demerec, 1937)

In the majority of x-ray experiments with *Drosophila*, treatment was given to males since they are more convenient to use for this purpose than females An adult male has a supply of mature sperm which, under normal conditions, lasts for several days In treating males, therefore, changes induced in mature sperm are produced

Sterility is the most noticeable after-effect observed in males treated with heavy dosages Although no exact figures are available, there is strong probability that a certain proportion of that sterility is due either to the killing or the inactivation of the sperm within the treated male Data

TABLE I —EFFECT OF IDENTICAL X-RAY DOSAGES ON THE FREQUENCY OF X-CHROMOSOME LETHALS IN TWO STRAINS OF *Drosophila melanogaster*

Dosage r units	Oregon R			Swedish b		
	Chromosomes Tested	Lethals	Percentage of Lethals	Chromosomes Tested	Lethals	Percentage of Lethals
Control	1049	2	0.066 ± 0.04	1627	3	0.18 ± 0.07
1.000	1000	13	1.30 ± 0.24	1015	20	1.97 ± 0.30
3.000	465	10	2.15 ± 0.45	383	23	6.01 ± 0.82
4.000	617	10	3.08 ± 0.47	458	31	6.77 ± 0.79
5.000	405	22	5.43 ± 0.76	233	25	10.73 ± 1.37

TABLE III—IMMEDIATE RESULTS

Ages over 40 years

Dose	Continued to Flow			Subsequent Treatment Required	*Bleeding Stopped after (Months)					Permanent Menopause	*Bleeding Returned after (Months)					Character of Return Flow			Subsequent Treatment
					1	2	3	4			4	8	12	24	60				
Mgm hr of Radium	Normal	Scant	Irregular	Profuse	X ray	Radium	Hyster-ectomy									Normal	Scant	Profuse	X ray
500								1	1	1									Hyster-ectomy
600								3	1	2	1	1					2		1
1200			1	1	1			1			1	1					1		
1800			1	1	1						1								
'Old x ray'																			
Modern x ray																			
300 r			1		1														
400 r																			
600 r								1			1					1			

* The term "bleeding" includes all types with regular menstruation or irregular bleeding. The columns to the left indicate those cases which continued to bleed after the treatment. Those to the right indicate the cases in which the bleeding stopped, either temporarily or permanently.

myoma smaller than the size of a two-months' pregnancy. One woman, receiving 600 mgm -hr of radium, became permanently amenorrheic (10 years). One, after 1,125 mgm -hr had a hysterectomy for continued bleeding. Two, after 900 mgm -hr, required supplementary x-ray and became permanently amenorrheic. Following x-ray, one woman chose hysterectomy rather than a permanent menopause when her periods returned. The periods of one woman became scant and irregular, the size of the uterus remained unchanged. Eight women had myomas the size of a three-to four-months' pregnancy. One, following 1,200 mgm -hr of radium, required a hysterectomy for continued bleeding. One after 1,200 mgm -hr, had regular periods, became pregnant after 18 months, aborted, and was not followed. Two, receiving 1,800 mgm -hr, required supplementary x-ray for continued bleeding and became permanently amenorrheic. One, treated by "old x ray," continued to have scant, infrequent periods for 10 years. One, treated by modern x-ray (600 r), required supplementary x-ray for continued bleeding and was scant and irregular for two years, then amenorrheic for 10 years. One, receiving 480 r, stopped after two months had one period after 13 months, and has been amenorrheic for two years. In all of these women the uterus has shrunk to normal dimensions. One woman, aged 33, had a uterus that ex-

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4,000	617	19	3.08 ± 0.47	458	31	6.77 ± 0.79

peat the curettage several times rather than institute any of the destructive measures now under discussion. There comes a time, however, when all devices have failed. The anemia is severe, transfusions may be necessary. The choice narrows down to three procedures: (1) x-ray treatment of the pituitary gland, (2) destruction of the endometrium by caustics or excision, (3) destruction of the ripe Graafian follicles by x-ray or radium. With the first type of therapy we have had little experience nor have we applied powerful caustics to the endometrium. It has been necessary to choose between some form of hysterectomy and radiation of the ovaries. In our hands this choice hinges upon the desirability of future child-bearing. If a woman has two or more children, it is often simpler for all concerned to perform an hysterectomy and leave the ovaries *in situ*. Contrary to some recent observations (Kretzschmar, 1935), it is our experience that menopause symptoms do not soon follow this procedure. The general appearance and sensations of the patients remain unchanged. Several women, followed more than 20 years, have never been conscious of hot flashes.

If, on the other hand, the woman desires to have children, an attempt at a partial sterilizing dose is the more conservative procedure. While there is always some risk of injuring the germ plasma and thereby predisposing to some anomaly in the child, the evidence collected by Murphy (1929) and Miller (1936) has not indicated that this has happened. Among our cases the two happy families with healthy children growing toward maturity compensate for the several failures. If, unfortunately, a permanent menopause should be established, the endocrine deficiency can easily be made up. The psychological aspects, however, are controlled with greater difficulty. If the therapist has studied the manifestations of the menopause, he will, before administering radiotherapy, have prepared the patient's mind for a permanent menopause. The management

of a woman suffering from symptoms of an unanticipated menopause can be a difficult problem indeed.

The management of fibromyoma in a young woman is highly individual. In a case in which treatment is necessary, some form of excision is nearly always advised and radiation given only when an operation is contra-indicated. In general, a partial dose has not been satisfactory. Bleeding is likely to continue and with the resumption of menstruation, the mass may increase in size. It is wiser in most instances to terminate menstruation and to treat the menopause, if hot flashes are severe, by the administration of estrogenic substances.

Dysmenorrhea, absent during the period of amenorrhea, usually recurs when menstruation returns. After all other efforts (general hygienic, endocrine, and psychic) have failed and a justifiable dilatation and curettage with insertion of a stem pessary has been attempted, frequently some radical therapy must be given. The choice then rests between a sympathectomy and radiotherapy. In this clinic results of sympathectomy have been good enough to make it preferable to a temporary menopause, despite the dangers incident to the laparotomy. If radiotherapy is instituted, it should be given with a clear understanding that the menstrual distress is likely to recur with the return of the periods.

DISCUSSION

Attempts to modify, but not terminate menstruation were made almost as early as the discovery of the effect of the rays upon the follicular apparatus of the ovary (Gauss, 1911). Techniques have been determined by two lines of thought. First, that there was a direct effect upon the endometrium, blood vessels, or myometrium which in some way modified the menstrual flow, second that the lasting effects of this method were brought about by the destruction of Graafian follicles. The evidence which we have would point toward the latter mechanism. Specimens of uteri which received a sterilizing dose of radium showed only a small proportion of



A

B

Fig 7 Silkworm caterpillars showing mosaicism induced by irradiation of the paternal sperm A, dark caterpillars show characters of the paternal strain and light show characters of maternal strain B first generation offspring of irradiated father showing mosaicism (From Astaurov 1937)

Another factor which should be taken into consideration is that there is no difference between somatic cells and germ cells as far as genic content is concerned. As a rule, all living cells of an organism possess a full complement of genes. Therefore, similar changes in the heredity-bearing material may occur both in germ cells and in somatic cells.

In attempting to interpret the evidence which shows that flies taken from two stocks of *Drosophila* were differentially affected by the same irradiation, it is well to keep the two facts just mentioned in mind. This result indicates that genes in one strain are more sensitive to irradiation than the genes of another strain. This difference in sensitivity could not be attributed to a difference between two sets of genes but rather to a difference in gene environment. This, in turn, suggests that similarly a difference in gene sensitivity

may be expected in different tissues of the same organism. Since changes in heredity-carrying material can readily be induced in somatic tissues and since an appreciable proportion of these changes is lethal to the cell such a difference in sensitivity would readily explain the differential lethal effect of irradiation in various tissues. This internal difference could account for reactions within the same organism whereby one tissue is injured or killed by a certain intensity of irradiation while another tissue may not show any detrimental effect at all. Similarly, this situation can explain the differential effect of radiation in the treatment of cancerous growth.

On the other hand, the observed differences in sensitivity to irradiation show that biological factors play an important role in the effects of x-rays on living organisms. It is evident that different individuals may be sensitive to a different degree to x-rays.

HEREDITARY EFFECTS OF X-RAY RADIATION¹

By M. DEMEREC, Cold Spring Harbor, N. Y.

From the Carnegie Institution of Washington

I SHALL introduce this discussion of the hereditary effects of x-ray radiation by outlining the general biological principles involved

these parts a number of definite constituents can be distinguished (Fig 1). Since certain nuclear constituents play the major rôle in heredity, I shall focus attention on

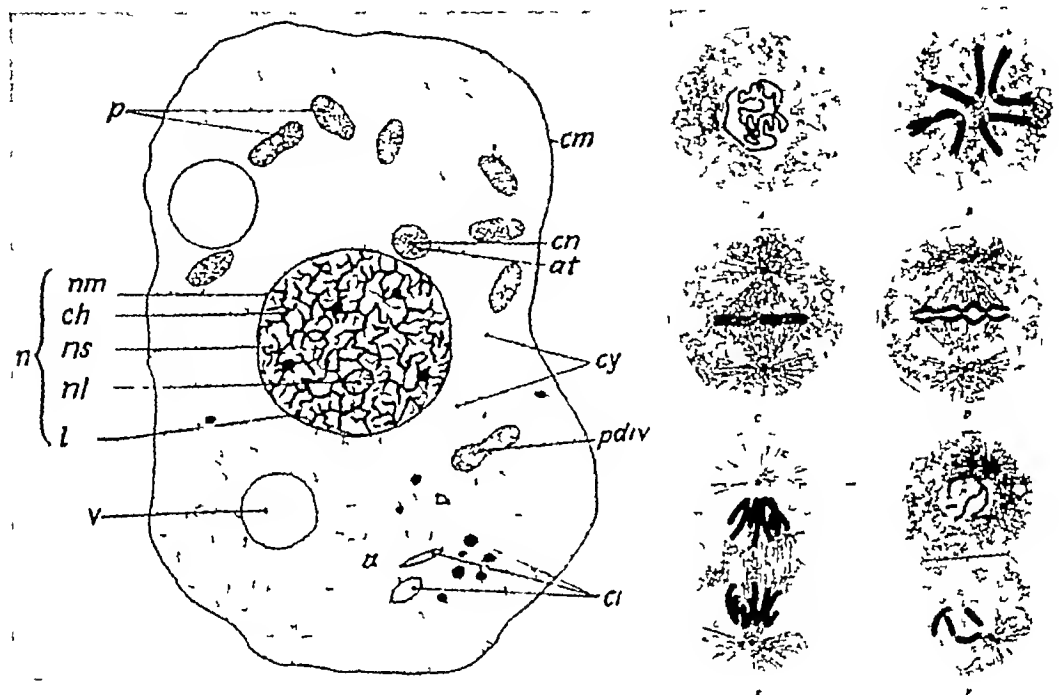


Fig 1 (left) Diagram of a typical cell. cm cell membrane, cy cytosome, n, nucleus, nm, nuclear membrane, v vacuole. (After A. F. Shull.)

Fig 2 (right) Semi diagrammatic representation of somatic cell division of *Ascaris*, a parasitic thread worm. A, early stage, chromatin thread slightly condensed; B, chromatin thread has formed into chromosomes which are arranged across the middle of the spindle; C, same as B, viewed from another angle; D and E, chromosome halves moving apart, cell body beginning to divide; F, division of cell body complete. (After A. F. Shull.)

PHYSICAL BASIS OF HEREDITY

The majority of living organisms, both animals and plants, are composed of a large number of cells. Through complicated processes these cells differentiate in various regions of a developing organism, thus building up different organs of a body. Generally, a living cell is composed of two parts: cytosome and nucleus. In each of

the nucleus and disregard the other parts of a cell.

Most living organisms begin life as a single cell which follows a union of a female gamete, or ovum, and a male gamete, or sperm. From this first cell the new individual acquires its volume through cell division and its form through cell differentiation. As the first step in cell division the diffuse mass of the nucleus becomes visibly organized into its constituents. Long delicate threads, known as chromosomes, be-

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

SURFACE AND DEPTH INTENSITIES FOR SHORT DISTANCE LOW VOLTAGE THERAPY

By M C REINHARD and H I GOODALE, *Buffalo, N Y*

From the State Institute for the Study of Malignant Disease, Burton T Simpson, M D , Director

RECENTLY several manufacturers have introduced shock-proof x-ray tubes for operation at low voltages (up to 140 kv p) for superficial therapy. The enclosing of such a tube in an insulat-

the quality of the beam and also since the shock-proof feature permits the use of shorter target-skin distances, the following measurements were undertaken in order to determine the quality, surface-field size,

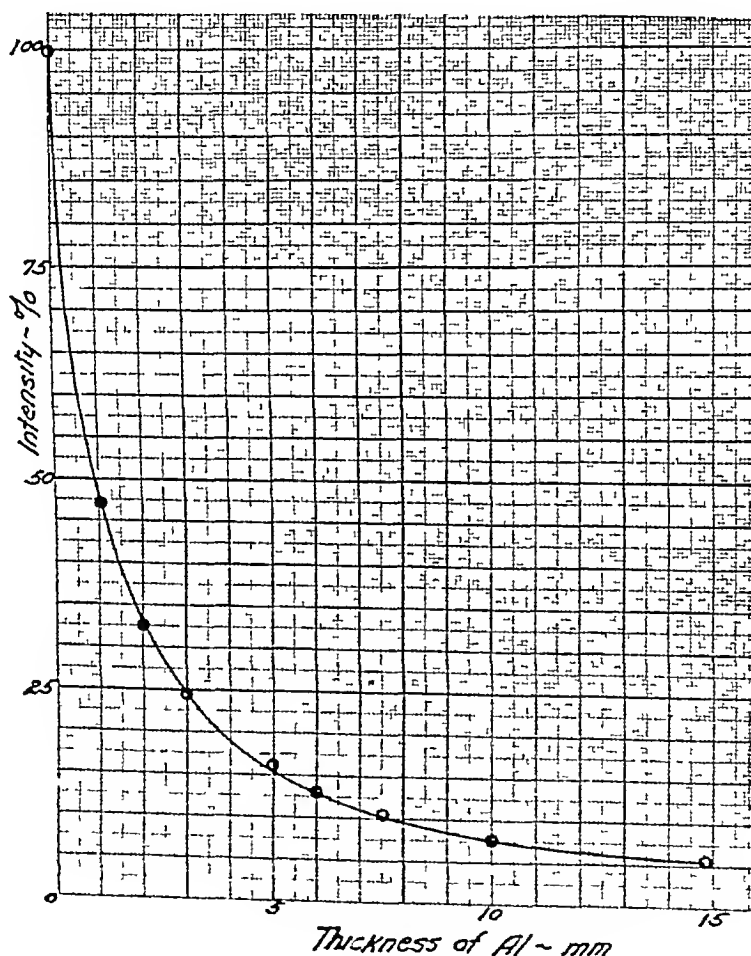


Fig 1 Aluminum absorption curve—no filter, 100 kv p (G E Co), shock proof tube type SP 1-4

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relationship, and relative depth intensities for such distances as might be used with this type of equipment, namely, 11, 15, and 20 cm target-skin distances. These data have been assembled in charts, which

Current genetic concept assumes that the whole complex of genes of a living cell forms a balanced biological system. The appearance of the whole organism, the activity of a group of cells and even of a single

degree of individuality and perform important functions which, in many cases, are vital to the cell.

HEREDITARY EFFECTS OF X-RAYS DIRECT OBSERVATIONS

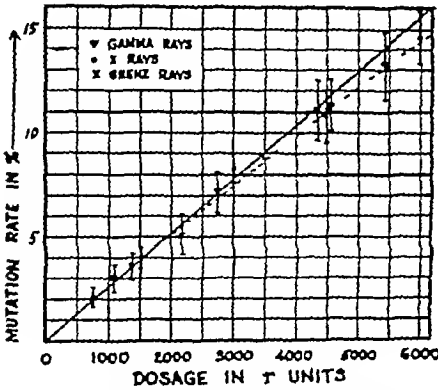


Fig 4 Action of different wave length on the rate of mutations in *Drosophila melanogaster*. Grenz rays = 10 kv, x rays = 50-150 kv, gamma rays = from radium (From Timofeef-Ressovsky and Zimmer, 1935)

cell is determined by the make-up of that system. Changes in genes affect the balance of the whole gene system. For example, if a change occurs in the white locus of *Drosophila*, that change, if present in a fertilized egg, will affect the gene system in such a way that the individual will develop white eyes instead of developing the normal red eyes. Similarly, a change in other genes again shifts the balance of the system and the observed result is the appearance of short wings, or cut wings, or small eyes, or some other definite hereditary character. Thus, genes are called "bearers of hereditary characteristics" or "units of heredity." They produce visible effects through their functioning in individual cells. Moreover, experimental evidence indicates they play an important rôle in the vital processes. Cases are known in which the elimination of even a single gene out of a set of 5,000 supposedly present in *Drosophila* upsets the normal activity of the cell to such an extent that its normal reproductive capacity is lost. It is known that every cell contains a large number of these ultramicroscopic particles, the genes, and that these genes have a high

degree of individuality and perform important functions which, in many cases, are vital to the cell.

Since chromosomes are carriers of genes and genes are determiners of hereditary characteristics, any detectable change in chromosomes should affect the hereditary capacity of a cell. Therefore, direct observations of chromosomes immediately following an x-ray treatment should reveal the nature of any induced changes.

One of the great difficulties in making direct cytological observations of x-ray effects is the fact that chromosomes are visibly differentiated in dividing cells only and that it is technically difficult to obtain large enough numbers of dividing cells to make the observations. For this purpose, plants seem to be more suitable material than animals. Huskins and Hunter's (1935) observations on *Trillium* indicate that x-ray treatment prevents or retards cell division and induces cell degeneration. The same authors and several others (Stone, 1933, Mather and Stone, 1933, Mather, 1934, Nebel, 1936) observed that cells dividing immediately after the treatment had sections of different chromosomes interchanged and pieces broken off. Such chromosomal aberrations are likely to affect the normal functions of a cell in which they are present. Interchange of sections is frequently accompanied by either a change or a loss of a small section of the chromosome at the breakage points. Such changes or losses produce heritable abnormalities which frequently are lethal, viz., they kill the organism. If as a result of treatment a chromosome becomes broken, an unattached piece may be lost during cell division, such a loss producing a deficiency for the genes located in the lost section and possibly having a lethal effect on the organism.

Cytological observations made immediately after treatment indicate, therefore, that x-rays induce pronounced changes in the hereditary material of a treated cell.

SURFACE AND DEPTH INTENSITIES FOR SHORT DISTANCE LOW VOLTAGE THERAPY

By M C REINHARD and H I GOODALE, *Buffalo, N Y*

From the State Institute for the Study of Malignant Disease, Burton T Simpson, M D , Director

RECENTLY several manufacturers have introduced shock-proof x-ray tubes for operation at low voltages (up to 140 kv p) for superficial therapy. The enclosing of such a tube in an insulat-

the quality of the beam and also since the shock-proof feature permits the use of shorter target-skin distances, the following measurements were undertaken in order to determine the quality, surface-field size,

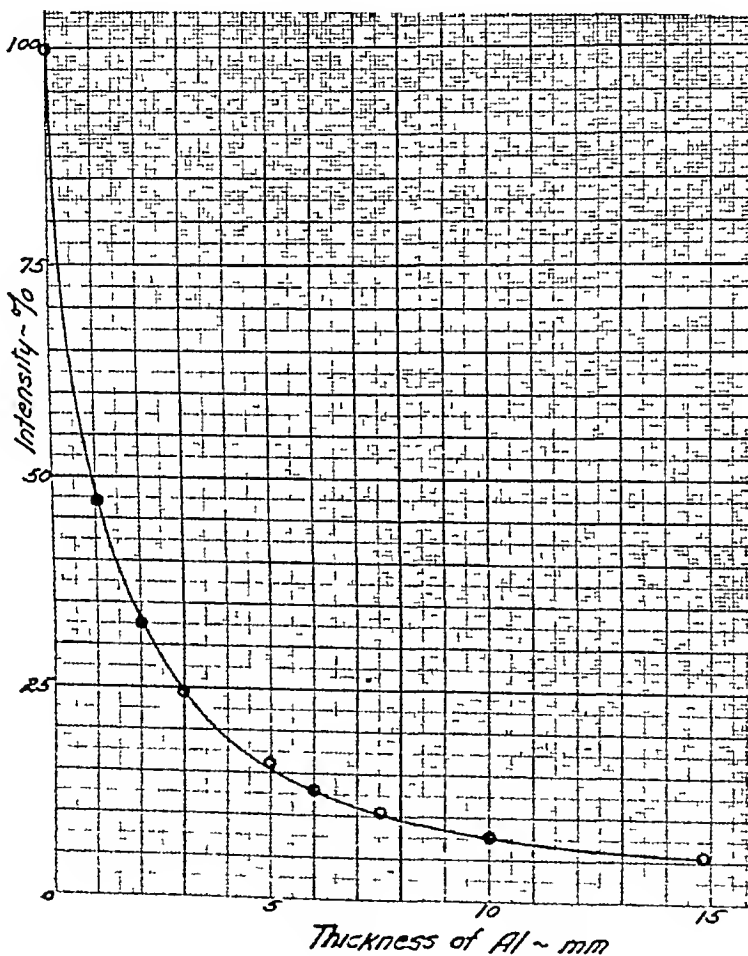


Fig 1 Aluminum absorption curve—no filter, 100 kv p (G E Co), shock proof tube type SP 1-4

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relationship, and relative depth intensities for such distances as might be used with this type of equipment, namely, 11, 15, and 20 cm target-skin distances. These data have been assembled in charts, which

an elimination of genes, it can be assumed that destructive processes are going on in places where changes are occurring. The

cases, the γ -ray treatment produces changes in the genes rather than gene eliminations.

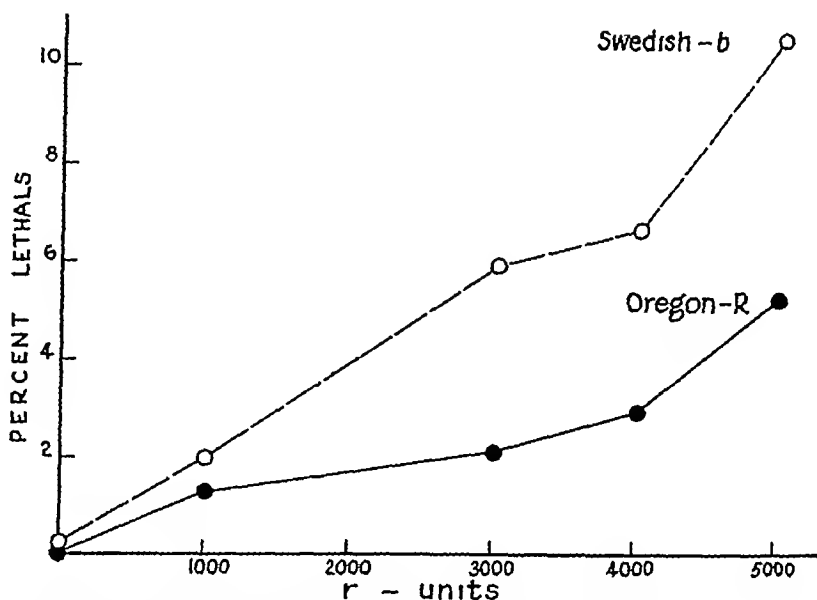


Fig 6 Percentage of X-chromosome lethals induced by identical treatment in two strains of *Drosophila melanogaster*

experimental evidence indicates also that a large proportion of detectable hereditary changes are lethal changes. The experimental evidence indicates, too, that these effects may be caused by a loss or inactivation of genes more commonly known as "gene deficiencies." It is not known how this process takes place. However, in order to eliminate a gene it is not necessary to destroy it, it is sufficient to induce a change which would deprive the gene of its power to reproduce. After one cell division such a gene is automatically eliminated from the gene complex of the daughter cells. It seems quite probable that many eliminations of genes result from such processes.

It is known, however, that not all changes induced by γ -ray radiation are the result of loss of hereditary-bearing material. In several cases changes were induced in normal genes and then by further treatment, the transformed gene was changed back into the original form. This evidence offers positive proof that, at least in some

Numerous experiments with *Drosophila* indicate that the effect of γ -rays is independent of the wave length within a range of about 0.01\AA to 2.2\AA (Schechtmann, 1930, Ephroimson, 1931, Hanson, Heys, and Stanton, 1931, Timofeeff-Ressovsky and Zimmer, 1935, Fricke and Demerec, 1937). Figure 4 presents graphically the data of Timofeeff-Ressovsky and Zimmer (1935) showing that similar dosages produce similar effects irrespective of the wave length used.

It has been shown also, that the frequency of lethals induced by γ -ray treatment is directly proportional to the dosage applied. Data dealing with this problem were summarized by Schultz (1936) and presented graphically in the chart shown in Figure 5. It should be noted, however, that Schultz used a correction factor for certain data bringing all curves to the same level.

Experiments by Patterson (1931) and by Timofeeff-Ressovsky (1934) show that applying a certain dosage in fractions did not have any influence on the induced mu-

using aluminum as the absorbing medium. A curve drawn from the data obtained from the aluminum absorption measurements indicates that when this tube is run

intensity measurements made with backscatter from the various fields is related to the air measurements as shown by the curve. We would like to emphasize that

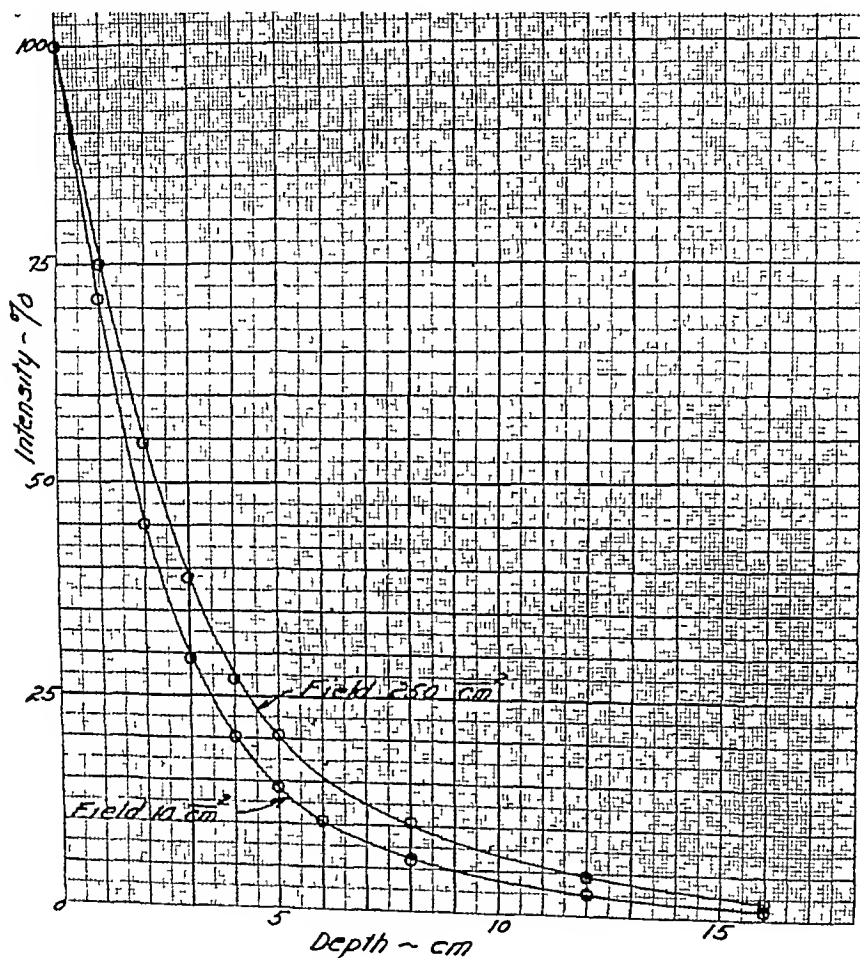


Fig 5 Depth intensities, distance 20 cm half value layer 0.9 mm aluminum

at 100 kv p, without additional filter, the half value layer is 0.9 mm aluminum (Fig 1). According to the Grebe Nitzge Tabellen, this corresponds to a half value layer of copper of 0.28 mm and an effective wave length of 0.57 \AA . When additional aluminum filtration is used, the approximate quality may be obtained from this curve.

In Figure 2, the relation between intensity and field size is given. The intensity as measured with the ionization chamber free in air is 100 per cent. The

this is an intensity curve and not a dosage curve.

The intensities for target-skin distances from 11 to 30 cm were measured with the ionization chamber free in air. The values obtained were compared with calculated values using the inverse square distance law. The agreement between the two was very close, indicating that this law holds also for these shorter distances.

Depth values are given in the following curves (Figs 3-5) for two field sizes at the three distances. These depth intensities

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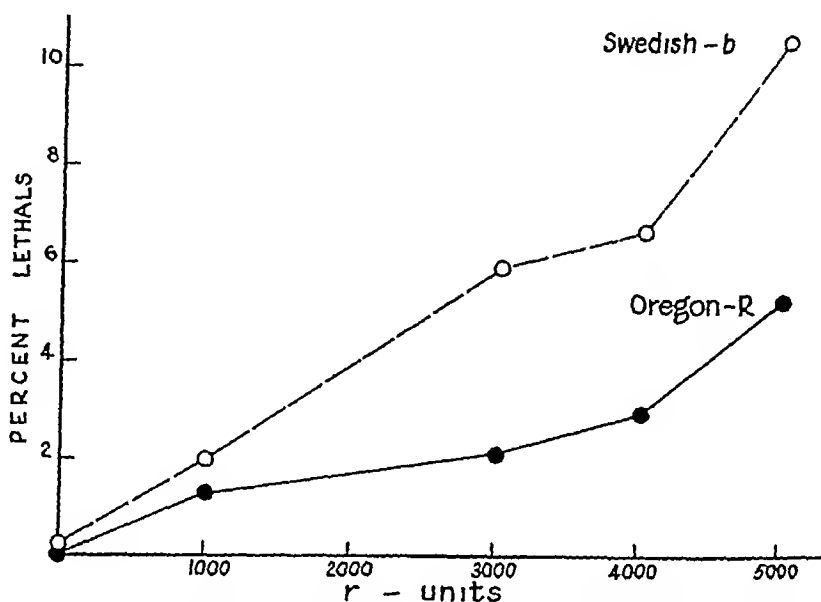


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ADVANCING OSTEOSCLEROSIS OF UNKNOWN ETIOLOGY¹

ROENTGENOLOGICAL MANIFESTATION OF A PROBABLE INFECTIOUS PROCESS OF THE BONE

By EUGENE FREEDMAN, M D , *Cleveland, Ohio*

From the Roentgen-ray Department of the University Hospitals

THE number of cases of osteosclerosis reported in the literature is great, and the conditions which lead to bone condensation are also numerous. The earliest cases reported in the roentgenological literature were those produced by metastatic tumors. The term "ivory vertebra" has been utilized for some time to name a vertebral body which casts an intense and homogeneous shadow, with a well maintained form and a normal sized intervertebral space on the roentgenogram and which is so commonly seen in prostatic metastases. Carcinoma of the breast has been also known to lead occasionally to osteoplastic metastases, although the osteoclastic form is more usual in this condition.

Hodgkin's disease is another condition in which osteoplastic bone changes occur, at times mainly in the pelvic bones and vertebrae. Hultén (8) reported the roentgenological finding of several compact, structureless vertebral bodies with well maintained form and contour, in a patient suffering with Hodgkin's disease. Fraenkel (5) similarly observed a case of Hodgkin's disease in which all the long bones showed an extensive, generalized ossifying periostitis.

Marble disease, a systemic condition first described by Albers-Schonberg (1), forms another group, in which the roentgenogram shows a generalized osteosclerosis, represented by an almost complete obliteration of the medullary portion and a marked thickening of the cortex of all the flat and long bones.

In osteopoikilosis described independently by Albers-Schonberg (2) and Ledoux-Lebard and Chabaneix (10), the roentgenogram showed all the bones to be

studded by innumerable, spherical areas of structureless condensation, generally measuring between three and eight millimeters in diameter.

The literature contains many cases in which, in connection with diseases of the blood, sclerotic changes occurred in the bones. Heuck (6) was the first to describe osteosclerotic changes in leukemia. Nauwerck and Moritz (12) demonstrated the simultaneous occurrence of osteosclerosis and atypical leukemia, while Reiche (14) found it in a case of aleukemic myelosis. Assmann (3) described generalized osteosclerosis in three cases of anemia and concluded that the osteosclerosis was related to the generalized disease of the blood-forming apparatus. Overgaard (13) made similar observations in a woman 41 years of age. Hirsch (7) reported a case of generalized osteosclerosis associated with essential polycythemia.

Paget's disease most commonly leads to a marked widening of the bones with rearrangement of the bone trabeculae in a fasciculated or mosaic-like fashion and to a thickening of the individual trabecula. Occasionally, however, Paget's disease may lead to the formation of dense, structureless bones. Jaffe (9) reported a case in which the gross appearance of the specimens showed zones of intense sclerosis without thickening of the bone, so that Paget's disease was nowhere suggested. Only the microscopical appearance revealed the true nature of the disease.

Møller and Gudjonsson (11), in 1932, described another condensing osteitis hitherto unknown to occur in humans. This condition was proven to be due to fluorine poisoning and was discovered among many employees of a factory who were exposed to cryolite dust. The bones of the thorax

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

obtained by Timofeeff-Ressovsky (1931) indicate that a high death rate during embryonic development is responsible for other cases of sterility (Table II). It is evident from these data that the sperm was so affected by irradiation as to cause a high death rate among the offspring.

Ample experimental evidence is available to show that from fertilizations with such treated sperm a large proportion of the viable offspring carries heritable changes which, in the majority of cases, are abnormalities of various types. Some of these are dominant and show up in the first generation offspring, others are recessive and may remain unobserved for generations until a chance fertilization brings together a male and a female gamete carrying the identical abnormality.

Abnormal individuals frequently appear among the first generation offspring of the treated sperm. Some of them are mosaics with one part of the body different from the rest. An example of such mosaicism is described by Astaurov (1937) in the silkworm (*Bombyx mori*). Females of a race with light colored caterpillars were crossed with irradiated males of a race with dark colored caterpillars. The first generation caterpillars are expected to be dark colored but a number of them were mosaics with one part of the body dark and the other light colored (Fig. 7).

All these effects of irradiation can be traced to changes in the heredity-bearing material, chromosomes and genes, and such changes are readily induced. It has been estimated (Demerec, 1936) that a dosage of 2,500 r-units produces in irradiated

Drosophila males, on the average, approximately one change per sperm.

Irradiation produces similar changes in ova and in somatic cells. It has been shown by Patterson (1929) that by irradiating *Drosophila* embryos or larvæ, distinct patches may be induced on the body of the adult fly—these patches having similar characteristics to those induced by the treatment of the gametes. The size of the patches corresponds to the stage of development at which the treatment is applied—large patches indicating changes which took place early in development, and small patches, those which occurred late. This evidence is a conclusive proof that x-ray irradiation induces changes in the hereditary material in somatic cells.

CONCLUSIONS

X-rays have been used extensively in genetic research since Muller's discovery (1927) of their influence on heredity and the high frequency with which they are able to induce hereditary changes. X-rays and related radiations are the most powerful agencies known at present for inducing hereditary changes, and they have made an extremely important contribution to theoretical genetics.

One important fact which should be kept in mind when the effect of x-rays is considered is that a great majority of detectable hereditary changes, both spontaneous and induced, are detrimental to the organism. A great many of them are lethal to organisms as a whole and some are even lethal to a single or to a few cells.

TABLE II—MORTALITY OF EGGS AND LARVÆ IN THE PROGENY OF *Drosophila melanogaster* MALES IRRADIATED WITH ABOUT 2,500 R-UNITS (AFTER TIMOFEEFF-RESSOVSKY, 1931)

Males	Number of		Percentage of Eggs Mortality	Number of Flies Emerged	Percentage of	
	Eggs Laid	Larvæ Hatched			Larval and Pupal Mortality	Eggs Developing into Adults
Treated	1,829	437	76.1	235	46.4	12.8
Control	4,763	3,738	14.5	3,348	10.4	76.5

of the blood were normal. Phosphatase ranged around 20 units (Bodansky). The red blood count varied between 4,850,000 and 4,000,000, with the hemoglobin varying correspondingly between 85 and 70 per cent and the white count from 12,000 to 8,500. The sedimentation rate was rapid, varying on different occasions between 15 mm and 0.9 mm per minute. The urine examination was negative. The development of rheumatic joints during his hospital stay suggested the fact that rheumatic fever played an important part in the subarachnoid hemorrhage. The roentgenological examination showed the sclerotic bone changes to have progressed. The back pain still persisted. The patient left the hospital 63 days after admission—improved.

He was re-admitted on Feb. 18, 1936. Examination showed that extremes of motion in the cervical vertebræ were painful, however, there was very little limitation. He stood in good posture, with no increase in his dorsal and lumbar curves. The legs were equal in length. All motions of his legs and hips were normal. There was a moderate limitation of forward and backward bending. Repeated calcium, phosphorus, and phosphatase determinations were again normal. The blood Wassermann and Kahn's precipitation tests were negative.

On Feb. 20, 1936, a piece of bone approximately $1.5 \times 1.5 \times 1.0$ cm. was removed from the crest of the right ilium. The piece was very firm and was composed of pale red cancellous bone. The microscopical sections, described by Dr. Harry Goldblatt, were composed of compact spongy bone with trabeculae that were thick, irregular, and well calcified. Some of these trabeculae showed definite parallel lamination, but no signs of mosaic formation. A single layer of osteoblasts was present around most of the trabeculae. In the spaces between the trabeculae there were only a few islands of normal bone marrow. The bone marrow was replaced by fibrous connective tissue which was either

richly cellular and dense or poorly cellular and edematous. In addition, in many of the spaces there were granulomatous inflammatory lesions, which consisted mainly of foci of epithelioid cells, within which, or surrounding which, were giant cells of the Langhans type. In the sections of one piece of tissue there was a zone of recent hemorrhage, in the immediate neighborhood of which some of the trabeculae showed degenerative changes and necrosis. Most of the trabeculae were well preserved and the nuclei of the bone cells stained quite distinctly. Special stains for tubercle bacilli failed to reveal any acid-fast or other micro-organisms in the granulomatous lesions. The diagnosis of osteosclerosis with granulomatous myelitis, possibly tuberculous, was made.

The chemical analysis of the piece of bone, together with some bone marrow, showed its water content to be 10.96 per cent. The normal water content of bone free of bone marrow is between 20 and 25 per cent, consequently the specimen contained less than one-half of the normal amount. The ash content was 59.5 per cent (normal about 40 to 45 per cent), an increase of about 15 to 20 per cent. The calcium content of the ash amounted to 41.7 per cent and the phosphorus 18.65 per cent, which is an approximately normal figure and ratio. The fluorine content was 0.035 per cent (normal 0.035 to 0.065 per cent).

The patient was re-admitted for further study on Dec. 5, 1936. Since his last discharge he had been wearing a back brace, which relieved his back pain to a great extent, but with a fairly marked stiffness and limitation of motion. The red blood cell count was 4,100,000 and the hemoglobin 78 per cent. The blood calcium, phosphorus, and phosphatase figures were within normal limits again.

ROENTGEN-RAY STUDIES OF THE BONES

Pelvic Bones and Upper Femora (Oct. 18, 1931, and Jan. 21, 1932).—Scattered throughout both iliac bones there are many circular areas of bone condensation

and that a dosage which is beneficial for one individual may be injurious to another or may be ineffective for a third. Such differences are expected to be especially frequent in man since cross-breeding, which is generally in force, favors variability among individuals of the human race.

LITERATURE CITED

- ASTAUROW, B. L. Versuche über experimentelle Androgenese und Gynogenese beim Seidenspinner (*Bombyx mori* L.) (Russian, German summary) Biol Zhur, 1937, 6, 3-50.
- DEMEREK, M. Heredity and Radiation. RADIOLOGY, August, 1936, 27, 217-220.
- DUBOVSKIY, N. V. On the Question of the Comparative Mutability of Stocks of *Drosophila melanogaster* of Different Origins. Compt Rend Acad Sci URSS 1935, 4, 95-97.
- EFROMSON, W. P. Die transmutierende Wirkung der X-Strahlen und das Problem der genetischen Evolution. Biol Zentralbl, 1931, 51, 491-506.
- FRICKE, H., and DEMEREK, M. The Influence of Wave Length on Genetic Effects of X-rays. Proc Nat. Acad Sci, 1937, 23, 484-488.
- HANSON, F. B., HEYS, F., and STANTON, E. The Effects of Increasing X-ray Voltages on the Production of Lethal Mutation in *Drosophila melanogaster*. Am Nat, 1931, 65, 134-143.
- HARRIS, B. B. The Effects of Aging of X-rayed Males upon Mutation Frequency in *Drosophila*. Jour Hered June, 1929, 20, 299-302.
- HUSKINS, C. L., and HUNTER, A. W. S. The Effects of X-radiation on Chromosomes in the Microspores of *Trillium erectum* Linn. Proc Roy Soc London, 1935, Series B, 117, 23-33.
- MATHER, K. The Behavior of Meiotic Chromosomes after X-radiation. Hereditas, 1934, 19, 303-322.
- MATHER, K., and STONE, L. H. A. The Effect of X radiation on Somatic Chromosomes. Jour Gen., 1933, 28, 1-24.
- MULLER, H. J. Artificial Transmutation of the Gene. Sci, 1927, 66, 84-87.
- Idem. The Problem of Genic Modification. Ztschr Indukt Abst u Vererbungsl, Sup 1, 1928, pp 234-260.
- NEBEL, B. R. Chromosome Structure X. An X ray Experiment. Gen, 1936, 21, 605-614.
- PATTERSON, J. T. The Production of Mutations in Somatic Cells of *Drosophila melanogaster* by Means of X rays. Jour Exper Zool, 1929, 53, 327-372.
- Idem. Continuous versus Interrupted Irradiation and the Rate of Mutation in *Drosophila*. Biol Bull, 1931, 51, 133-138.
- SCHUCHTMANN, J. Der Mutationseffekt und die quantitativen Gesetzmässigkeiten der Röntgenstrahlenwirkung (Russian, German summary) Zhur Exper Biol, 1930, 6, 271-279.
- SCHULTZ, J. Radiation and the Study of Mutation in Animal. In "Biological Effects of Radiation," 1936, 2, 1209-1261.
- STONE, L. H. A. Effect of X-radiation on the Mitotic Division of Certain Plants. Ann Bot, 1933, 47, 815, 816.
- TIMOFEEFF-RESSOVSKY, N. W. Einige Versuche an *Drosophila melanogaster* über die Art der Wirkung des Röntgenstrahlen auf den Mutationsprozess. Roux, Arch Entwicklunsmech d Organ, 1931, 124, 654-665.
- Idem. The Experimental Production of Mutations. Biol Rev, 1934, 9, 411-457.
- TIMOFEEFF-RESSOVSKI, N. W. and ZIMMER, K. G. Wellenlängenunabhängigkeit der mutationsauslösenden Wirkung der Röntgen- und Gammastrahlen bei *Drosophila melanogaster*. Strahlentherapie, 1935, 54, 265-278.
- TIMOFEEFF-RESSOVSKY, N. W., ZIMMER, K. G., and DELBRÜCK, M. Ueber die Natur der Genmutation und der Genstruktur. Nachr Ges Wiss Göttingen, 1936, 1, 189-245.

measure between 2 and 3 cm in diameter, the oval ones 1.5×2 to 2.5×5 cm. In the medial portion of the right ilium, near the sacro-iliac joint, several of the circular areas are confluent.

The contours of the areas of condensation show a fine fuzziness, but otherwise they are sharply demarcated from the neighboring normal osseous structures. The central portion of the sacrum shows an oblong area of condensing lesion measuring 7 cm in length and 4 cm in width. The ischium and pubic bones likewise show oblong areas of condensing lesion. The sacro-iliac and hip joints appear to be normal (Fig 1).

Vertebral Column—There is an extensive sclerosing process involving the lower six dorsal and all the lumbar vertebrae. Some of the sclerotic areas are circular, but are not as sharply demonstrated as those of the pelvic bones. The sclerosis of the



Fig 3 Lateral view of lumbar vertebrae demonstrating the areas of bone condensation. The contours of the vertebral bodies are normal.

are useful, not only for these new shock-proof tubes, but also in transition from the old unprotected unfiltered superficial technique to the new type of tubes and treatment

the density of which was the same as that of water. The x-ray tube was the shock-proof, oil-immersed General Electric X-ray Company tube, type SP 1-4, having

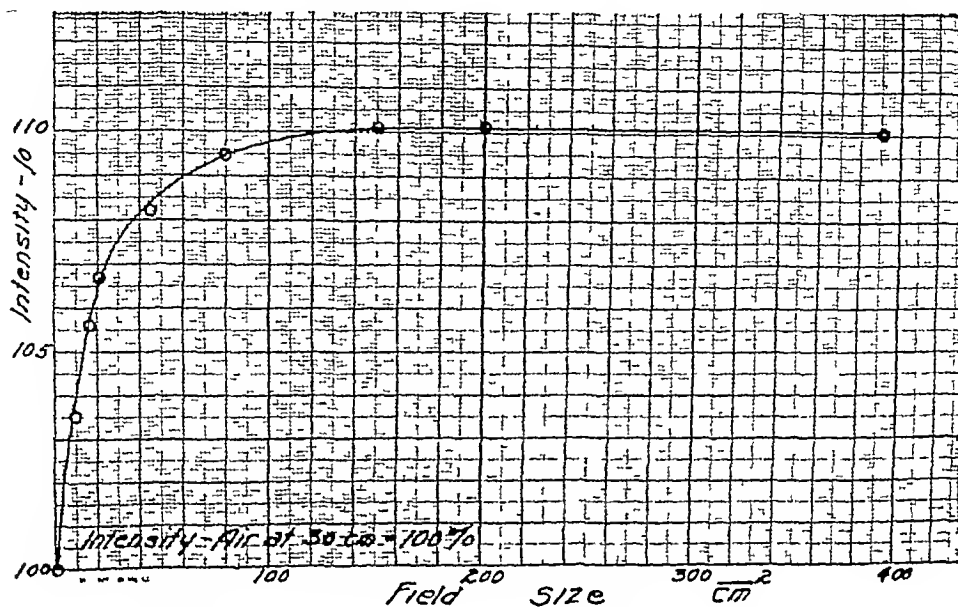


Fig 2 Back scatter with various sized fields, half value layer 0.9 mm aluminum

For this work all measurements were made with a Victoreen condenser r meter, used in conjunction with a wood phantom,

an inherent filter equivalent to 0.5 mm aluminum

Quality measurements were first made

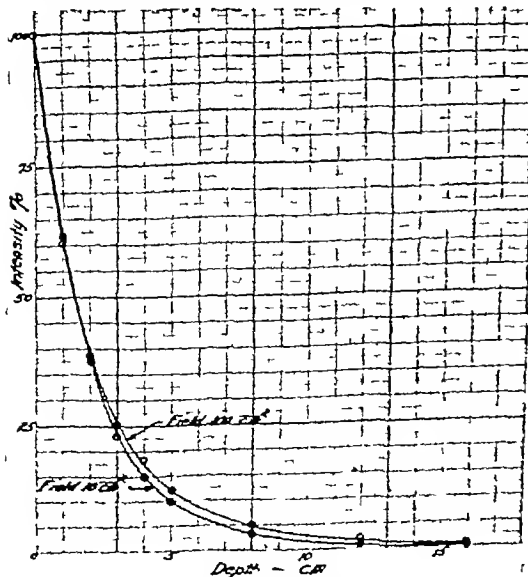


Fig 3 Depth intensities distance 11 cm half value layer 0.9 mm aluminum

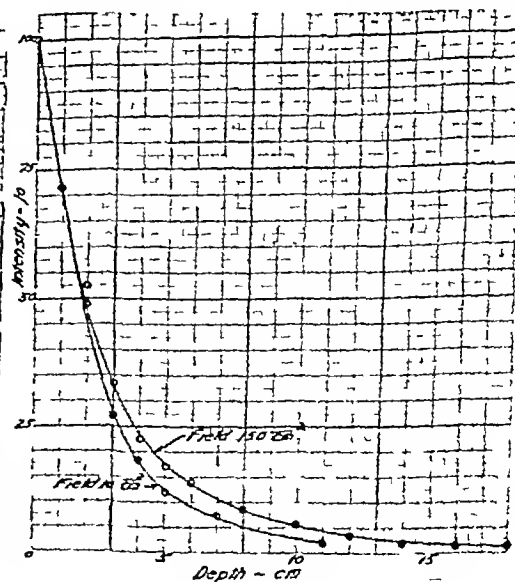


Fig 4 Depth intensities distance 15 cm half value layer 0.9 mm aluminum



Fig 1 Taken on Oct 8 1931 this film shows rather sharply defined circular and oval areas of condensation scattered throughout the pelvic bones

The normal architecture of the bone is either completely obliterated or indistinct throughout these areas. The trabeculae show a marked thickening and the intertrabecular spaces are either absent or markedly narrowed. The circular areas



Fig 2 The lumbar vertebrae also show scattered areas of condensation which are irregularly defined





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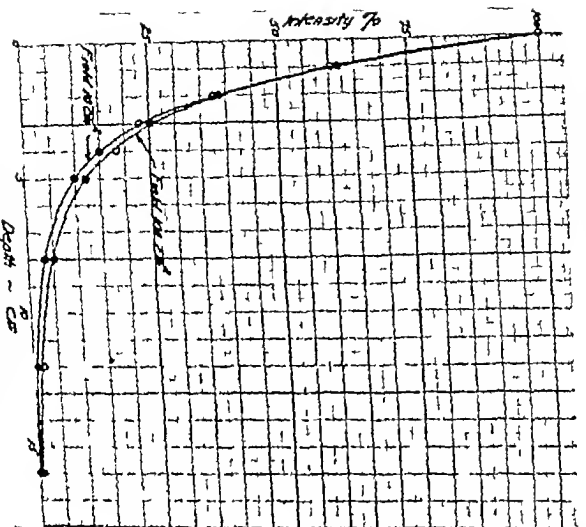


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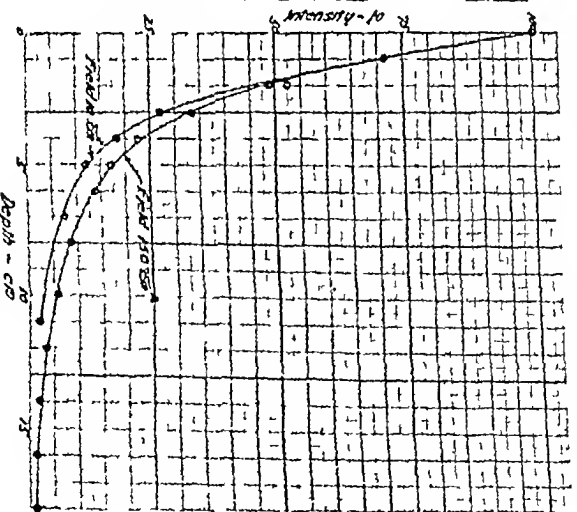


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measure between 2 and 3 cm in diameter, the oval ones 1.5×2 to 2.5×5 cm. In the medial portion of the right ilium, near the sacro-iliac joint, several of the circular areas are confluent.

The contours of the areas of condensation show a fine fuzziness, but otherwise they are sharply demarcated from the neighboring normal osseous structures. The central portion of the sacrum shows an oblong area of condensing lesion measuring 7 cm in length and 4 cm in width. The ischium and pubic bones likewise show oblong areas of condensing lesion. The sacro-iliac and hip joints appear to be normal (Fig 1).

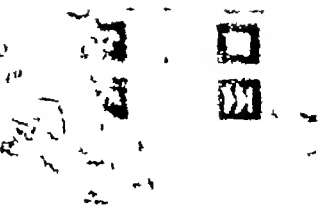
Vertebral Column—There is an extensive sclerosing process involving the lower six dorsal and all the lumbar vertebrae. Some of the sclerotic areas are circular, but are not as sharply demonstrated as those of the pelvic bones. The sclerosis of the



Fig 2 The lumbar vertebrae also show scattered areas of condensation which are irregularly defined



Fig 3 Lateral view of lumbar vertebrae demonstrating the areas of bone condensation. The contours of the vertebral bodies are normal.



222

RADIOLOGY

are useful, not only for these new shock-proof tubes, but also in transition from the old unprotected unfiltered superficial technique to the new type of tubes and treatment

the density of which was the same as that of water. The x-ray tube was the shock-proof, oil-immersed General Electric X-ray Company tube, type SP 1-4, having



Fig 6 Anteroposterior view of the lumbar vertebrae taken three years after the first examination, showing the sclerosis of the vertebral bodies to have become uniform



Fig 7 The sclerosis extends into the cervical vertebral bodies

showed some condensation. The patient's clinical condition remained very good, and the only symptom referable to the bone lesion was an intermittent dull, aching pain in the back with practically no disability.

The biopsy of the bone showed a thickening of the bone trabeculae with a granulomatous myelitis suggesting tuberculosis, yet no tubercle bacilli were found in any of the sections. Consequently, the microscopical examination failed to give full information as far as the etiology of the disease was concerned.

The chemical analysis showed only increased ash content and diminished water content, but otherwise normal composition. It helped to rule out fluorine poisoning.

Despite the severe osteosclerosis of many of the flat bones, the blood picture remained relatively normal. Apparently the normal bone marrow of the uninvolved bones was still able to compensate for the loss of the blood-forming spaces in the diseased bones. The approximately normal blood picture likewise enabled one to eliminate a bone disease associated with

blood dyscrasias. Syphilis of the bones had been ruled out by the repeatedly negative spinal fluid and blood Wassermann and Kahn precipitation tests. There were no clinical manifestations to indicate the presence of Hodgkin's disease. Metastatic tumors and Paget's disease were eliminated by the microscopic study and the clinical course. Neither the roentgenological appearance, the blood chemistry, nor the histological examination indicated the presence of hyperparathyroidism.

Apparently the disease represents a low grade bone infection either of tuberculous or pyogenic etiology. It probably belongs in the same group of cases which were reported by Bársony and Polgár, and subsequently by Rendich and Shapiro. Yet in their cases, the roentgenological manifestations are quite different, the disease being localized to the medial portion of the ilium.

As far as tuberculosis is concerned, there is nothing in the patient's clinical history and symptomatology to indicate the presence of this condition. The lung-fields are

TABLE I —DEPTH INTENSITIES
(Half Value Layer = 0.9 mm Aluminum)

Depth (cm)	11 cm distance		15 cm distance		20 cm distance	
	Field 100 cm ²	Field 10 cm ²	Field 150 cm ²	Field 10 cm ²	Field 250 cm ²	Field 10 cm ²
0	100 00%	100 00%	100 00%	100 00%	100 00%	100 00%
1	62 25	61 5	71 25	71 3	75 0	71 0
2	39 0	38 5	52 75	48 8	54 3	45 0
3	25 3	23 3	33 25	27 1	38 7	29 25
4	18 0	14 7	22 5	19 0	26 6	20 0
5	12 0	10 0	16 75	12 0	20 2	14 0
6	9 0	6 8	13 8	9 5	15 8	10 25
7	6 75	5 0	10 6	7 0	13 0	8 4
8	5 5	3 7	8 1	5 0	10 75	6 4
9	4 2	2 75	6 75	3 7	8 4	5 0
10	3 25	2 0	5 4	2 5	6 6	3 8
11	2 5	1 5	4 4	1 75	5 25	3 0
12	2 0		3 0		4 5	2 2
13	1 5		2 9		3 5	1 8
14	1 25		2 2		2 9	1 5
15	1 0		1 8		2 0	1 3
16	0 8		1 5		2 0	0 75

are tabulated in chart form in Table I. The field sizes are 10 sq cm for a small field and for a large field the maximum spread of the beam is utilized. This last is 100 sq cm at 11 cm distance, 150 sq cm at 15 cm distance, and 250 sq cm at 20 cm distance. The depth intensities for the intermediate field sizes can if necessary be interpolated from these values, although the difference between the curves at the shorter distances is too small to make this necessary.

It is planned to expand this work to include aluminum filtration of various thicknesses

SUMMARY

Surface and depth intensities are given for a shock-proof x-ray tube operated at 100 kv p (half value layer 0.9 mm aluminum) for the following distances and field sizes

- 1 11 cm target-skin distance, 10 and 100 sq cm fields,
- 2 15 cm target-skin distance, 10 and 150 sq cm fields,
- 3 20 cm target skin distance, 10 and 250 sq cm fields

NEUROBLASTOMA A CHILDHOOD TYPE OF MALIGNANT TUMOR OF THE SYMPATHETIC NERVOUS SYSTEM

By I S STARTZ, M D , and J ABRAMS, M D , *Elmhurst and Brooklyn, N Y*

THE fact that we have encountered two cases of neuroblastoma, a comparatively rare disease, within a period of one year, has prompted us to report these cases and, in addition, to review some of the literature dealing with this fascinating subject

Definition—Neuroblastoma can be defined as a malignant tumor, derived from neuroblasts. However, this statement conveys no significant impression unless one is familiar with the embryonic stages in the cellular development of the nervous system

Embryology—The medullary epithelium is formed of primitive undifferentiated nerve cells of ectodermal origin. Early in the course of histogenesis of the nervous system, these cells lining the medullary groove differentiate themselves into two main divisions—*germ cells* and *spongioblasts* (Fig 1)

The germ cell in turn gives rise to two types of cells, the neuroblast and the medulloblast. The neuroblast ultimately becomes the neuron or adult nerve cell. Both the neuroblast and the neuron have an affinity for silver (which fact is utilized to advantage for identification by means of this staining selective property). The neuroblasts are not only the precursors of neurons but also give rise to migrating cells (springing from ganglionic cells), the anlage of the sympathetic nervous system. Some of the neuroblasts migrate ventrally toward the aorta to form the sympathetic chains and the chromaffin paraganglionic structures, and also invade the mesodermal part of the suprarenal gland to form the chromaffin and ganglion tissue of the medulla (19). The medulloblast has no affinity for silver or gold. It is believed that the medulloblast can develop into a spongioblast or a neuroblast, or may give rise to an adult type of neuroglial cell called oligodendroglia.

The other main cellular division of the medullary epithelium manifests itself as spongioblasts. During the process of maturation these cells pass through the ripening phases of astroblasts, protoplasmic, and fibrillary astrocytes, and finally become the adult glia or neuroglia cell which is the important supportive cellular structure of the central nervous system. These elements stain with gold impregnation methods.

Gliomas are derived from glia or neuroglia cells, and are the common tumors of the central nervous system. For some unexplained reason, the primitive neuron elements are more apt to exist in the sympathetic nervous system than in the central nervous system, and so neuroblastomas are more generally found in the sympathetic chains and in the adrenal cortex, more frequently in the latter.

Study of Figure 1 will be of great aid in visualizing the transitional stages of the cellular development of the nervous system, and the specific type of tumor derived from each of these cells. This schematic chart has been formulated from composite data derived from literature published by Bailey (1) and Boyd (2).

Pathology—In the older literature, neuroblastoma of the adrenal was mistaken for sarcoma because of the soft cellular sarcoma-like appearance of the tumor tissue. It was Virchow, in 1864, who first guessed at the nervous tissue origin of these congenital suprarenal tumors, but he regarded them as gliomas. Kuster (12), Lapointe and Lecène (13) reported tumors composed of undifferentiated sympathetic cells as gliomas of the adrenal, believing the rosettes were embryonic misplaced glia tissue. Wright (23), in 1910, was the first to properly name the tumor as "neuroblastoma." Quoting him—

'Histologically the tumor is very cellular, resembling primitive migrating cells of the sym-

vertebræ, pelvis, and of the extremities showed on the roentgenogram a more or less marked condensation, the normal osseous structure having been replaced by a milky white opacity

Finally, there is a group of sclerotic osteitis of unknown etiology. Sicard, Gally, and Haguenau (16) were the first to use this term in 1926. They reported five cases of condensing osteitis. However, these authors' patients were not carefully studied. Only one examination was performed in each case, there were no histological studies, and the period of observation was short, amounting to two or three months only. On studying the reproductions of their cases, one gains the impression that with the exception of one case, all of them could have been due to metastatic tumors.

Bársony and Polgár (4), in 1928, reported a condition described by them as *ostitis condensans ili*. They observed several patients in each of whom the ilium showed a localized sclerosis in the neighborhood of the sacro-iliac joint. The authors were unable to perform serial examinations and were likewise unable to determine the etiological factor in their cases.

Rendich and Shapiro (15), in 1936, reported 12 cases, in which the roentgenologic findings were identical with the cases reported by Bársony and Polgár. Some of their patients presented clinical symptoms, usually of the low back pain type. The disease was found to occur in both sexes. The examination of the entire osseous system failed to show evidence of multiplicity, except that occasionally the opposite ilium was also found to be involved. In one of the cases, during an operation for sacro-iliac fusion, a piece of bone was removed for histological examination and the changes were found to be due to an inflammatory process. The author concluded that the disease did not fall within the category of the known bone diseases, the etiology and the pathogenesis of the condition was unknown, and its clinical significance was debatable.

The present report is concerned with a case in which progressive sclerotic bone changes occurred in the pelvic bones, vertebræ, and scapulæ associated with mild clinical symptoms. The patient had been under observation for almost six years and in spite of careful clinical roentgenological, microscopical, and chemical study, no definite conclusions could be reached concerning the nature of the condition. The lesions to be discussed subsequently do not bear any resemblance to any of the hitherto described bone lesions of either known or unknown etiology.

R. W., a colored male, entered the University Hospitals in October, 1924, when he was 16 years of age. Following an attack of sore throat and migratory multiple joint pains, he developed a pericarditis and endocarditis. Pericardiectomy was done and 450 c c of reddish-brown fluid was removed. The fluid contained pneumococci. His general condition improved, but a hypertrophy of the left heart and a systolic and diastolic murmur remained stationary. In 1931, at the age of 21 years, he registered at the Out-patient Department because of pain at night—only in his back and left knee. X-ray examination at this time showed areas of bone sclerosis scattered throughout the upper portions of both ilia, the sacrum, and the lumbodorsal vertebræ which simulated the appearance of prostatic metastatic tumors.

The dull, aching bone pains persisted until the next admission in September, 1934. A few days before this admission the patient was seized with a sudden pain in the back of his head and neck. Lumbar puncture was done and it showed a pressure of 450 mm of water, normal dynamics, and grossly bloody fluid. The fluid was not xanthochromic. Wassermann and gum mastic tests were negative. The diagnosis of spontaneous subarachnoid hemorrhage was made. During his stay in the hospital he developed severe pain in both wrists which responded to amygdopyrine. The systolic and diastolic murmurs over the aortic area were still present. Repeated calcium and phosphorus determinations



Fig 2 Case 1 (Left) Lung tumor in right upper chest (Right) Right upper chest over penetrated to demonstrate partial calcific infiltration of tumor

bital region, and to other osseous structures. There is generally first noticed an ecchymotic spot about one eye, followed later by unilateral exophthalmos, with tumefaction of the temporal region. The abdominal findings generally are of a minor character. The orbital involvement is more apt to occur on the same side as the primary adrenal tumor. Sturtevant and Kelly (21) emphasize the fact that ecchymosis of the eyelids and proptosis, occurring in infants or children, should arouse suspicion of metastasis from a suprarenal growth.

The age group frequently determines the type of syndrome, those in the Pepper class existing more frequently during the infantile stage and the Hutchinson type is more apt to be found during the childhood period. Many cases have been reported in recent years that do not seem to fit into either the Hutchinson or Pepper type. Frequently there are no ocular findings, and the primary tumor does not always occur in the suprarenal structure as in Case 1, reported in this communication.

X-ray Findings—Only when there is metastasis to the osseous system can neuroblastoma be suspected or recognized roentgenologically. The tumor generally invades the skull, pelvis, and long bones. The exophthalmos is produced by metastasis in the region of the orbit. The skull findings are generally characteristic (Fig 3, Case 1). Numerous pin-hole vacuolated areas are seen in the frontal region and to a lesser extent in the entire vault. The cranium frequently has a moth-eaten appearance. Thinning of the cortex is often present, with gaping of suture spaces (9). The shafts of the long bones and the flat bones exhibit small areas of resorption. Periosteal reaction changes in the form of "perpendicular striations," "spicules," and "whiskers" have been described by Henle (6), Lewis (15), Tidswell and Sear (22), Lederer (14), Klein (11), and Rypins (20). Geschickter and Copeland (3), on the contrary, state that periosteal new bone formation is unusual in neuroblastoma.

Radiation Therapy—Boyd (2), Kwartan and Twiss (10), and Holmes and Dresser



Fig 4 Shows the appearance of the condensing areas in the dorsal vertebrae

eleventh and twelfth dorsal and the first lumbar vertebrae involves uniformly the entire vertebral bodies. The upper six dorsal and the cervical vertebrae show a similar, but less marked, change. Neither the arches nor the spinous or transverse processes are involved. The small intervertebral joints and the intervertebral spaces are normal (Figs 2, 3, and 4).

The ribs, clavicles, and the bones of the skull show no abnormalities.

Humeri and Scapulae—The necks of the scapulae show some diffuse, but not extensive condensing lesion (Fig 5). The humeri are normal.

The sclerotic process throughout the pelvic bones (examinations Oct 3, 1934, and Jan 10, 1935) has become generalized and the dense areas have become confluent. Only the central portions of the ilia and the distal end of the sacrum show normal architecture. The condensing lesion of the vertebral bodies has likewise progressed, they are uniform in density and ivory-like. The cervical vertebrae are also involved (Fig 6). The configuration



Fig 5 The neck of the scapula shows a marked sclerosis

of the pelvic bones and vertebrae are well maintained despite the marked structural changes. The cervical vertebrae and the necks of the scapulae are also denser than before.

The appearance of the pelvic bones and vertebrae on Nov 5, 1935, remains unchanged. Several additional long bones were examined and were found to be normal.

The sclerotic bone changes, as observed Nov 20, 1936, have progressed slightly (Figs 8 and 9).

DISCUSSION

The changes found in this patient's bones are unusual. The initial examination showed circular and oval areas of condensing lesions in the pelvic bones and vertebrae in a 21-year-old colored individual. They were suggestive of metastatic tumors of the type seen in prostatic carcinoma. However, the patient's age and the normal appearance of the prostate did not seem to justify this diagnosis. During an observation period of almost six years, the well demarcated lesions became confluent, leading to a generalized condensation of ivory density of all the involved bones, with well maintained contours and forms. Among the remaining bones only the necks of the scapulae



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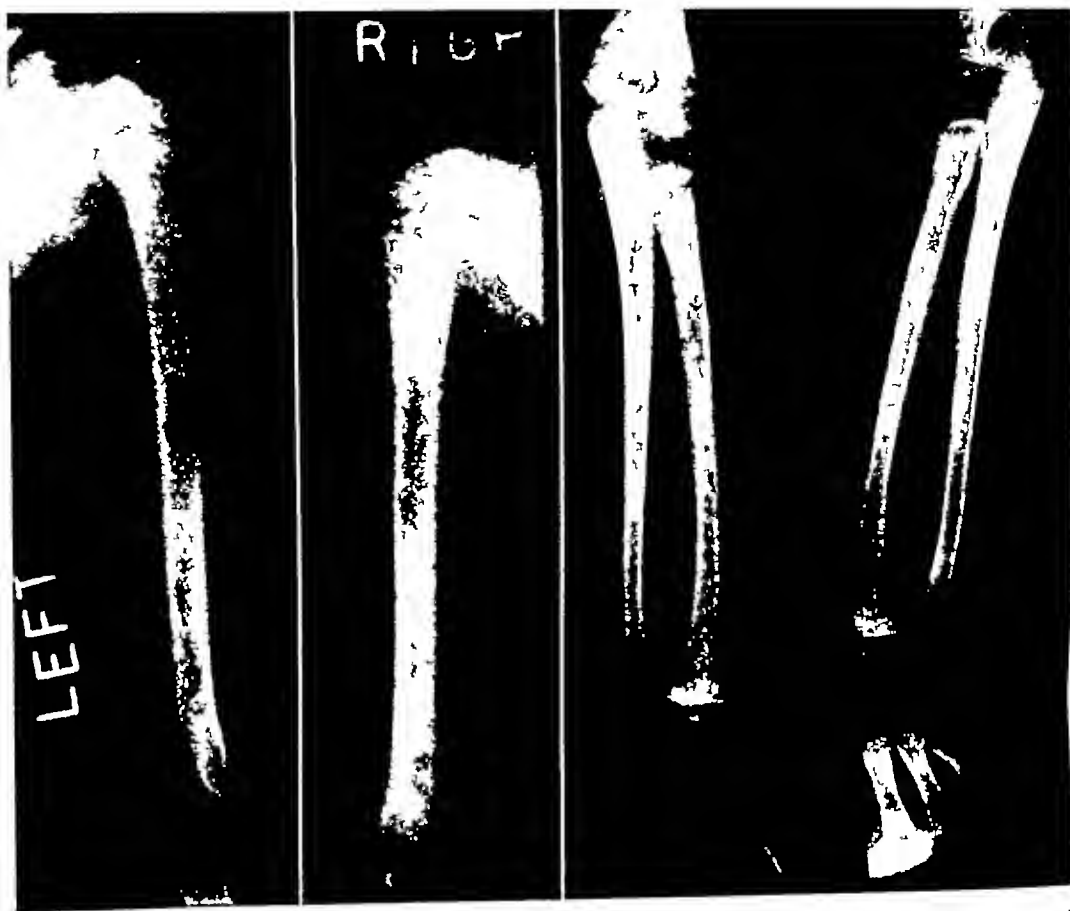


Fig 4 Case 1 (Left) Intramedullary osteolytic areas in shaft of left humerus and punched out zone of bone destruction at proximal end of diaphysis of right humerus externally (Right) Intramedullary rarefying areas in radius and ulna bones with partial destruction at proximal end of diaphysis of each radius externally

Physical status of the patient remained approximately the same for about ten days, after which he became progressively worse. Transfusion was given. On December 25, a hard irregular glandular mass was discovered in the right inguinal region. Biopsy report of inguinal lymph nodes follows:

"Gross description" Specimen consists of four portions of tissue and consists of several discrete lymph nodes. One portion measures $20 \times 10 \times 15$ mm, the other three particles measure approximately 5 mm in diameter and are discrete. A whitish tissue is noted on section, with no distinct architecture.

"Microscopic description" (Fig 6) Section shows delimited area of cellular tumor tissue with hyperchromatic but rather uniform nuclei, with distinct trabeculated, lobulated, and

alveolar structure. Distinct fibrils can be made out in association with some of the cells. No distinct characteristic rosettes are evident in the section. Some areas of necrosis and some vascular invasion and extension are noted. Lymph node structure is lost in most of the section. In one fragment sinusoids are found filled with hyperchromatic tumor tissue, with intervening thin columns of lymphoid stroma.

"Pathological diagnosis" Malignant infiltrating tumor suggesting neuroblastoma"—A. Angrist.

Four x-ray high voltage treatments were given over the dorsal spine and three over the right anterior chest, each treatment consisting of 100 r units. No beneficial effect was noted.

The child became weaker, with tempera-



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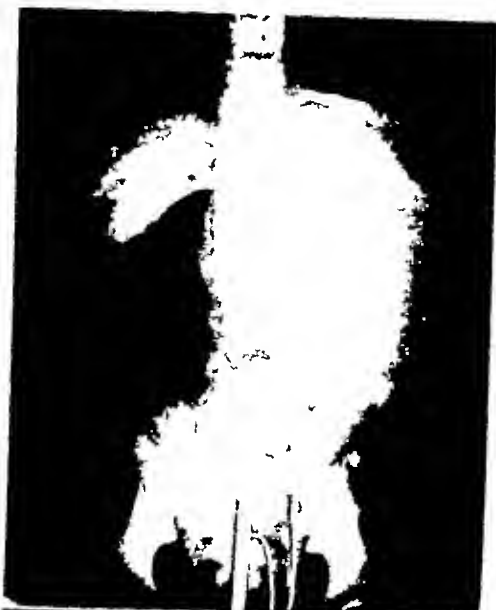


Fig 7 (*Upper*) Case 2 Left retrograde urography Tumor mass in left upper quadrant with downward displacement and flattening of left kidney pelvis and its calyces

Fig 8 (*Middle*) Case 2 Destruction of inferior angle of right scapula (*Lower*) Destruction of outer end of right eleventh rib

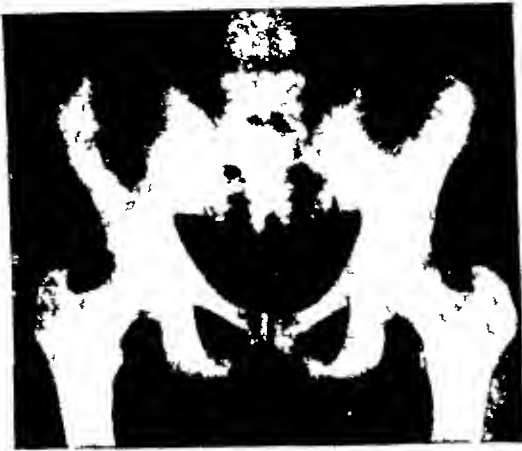


Fig 8 Film of pelvis taken five years after the first examination shows that the sharply defined areas of condensation have become confluent. Only the central portions of the ilia remain unsclerosed.

clear, and roentgen-ray examination of the abdomen shows no evidence of calcified mesenteric or retroperitoneal nodes.

On the other hand, there is ample evidence in the patient's clinical history of previous non-tuberculous infections. He had a septic pericarditis in 1924, which necessitated surgical intervention. The patient suffers from an aortic and mitral valvular disease, and there is a history of repeated rheumatic involvements of several small joints. There is likewise a history of a spontaneous subarachnoid hemorrhage which clinically was thought to be rheumatic in origin.

There is a possibility that through bacterial embolism with slightly virulent micro-organisms a low grade infectious process was originated in the involved bones, leading to a secondary condensing lesion, without evidence of suppuration.

We are presenting this case to the members of the International Congress in the hope that someone may help to elucidate the true nature of the disease.

REFERENCES

- (1) ALBERS-SCHÖNBERG. Eine bisher nicht beschriebene Allgemeinerkrankung des Skelettes. *Fortschr a d Geb d Röntgenstrahlen* 1907 11, 261.
- (2) Idem. Eine seltene bisher nicht bekannte Struktur-anomalie des Skelettes. *Fortschr a d Geb d Röntgenstrahlen* 1915-1916 23, 174.
- (3) ASSMANN A. Beiträge zur osteosklerotischen Anämie. *Beitr z path Anat u z allg Path* 1907 41, 565.
- (4) BARSONY T and POLGAR F. Ostitis condensans ili—ein bisher nicht beschriebenes Krankheitsbild. *Fortschr a d Geb d Röntgenstrahlen* May 1928 37, 663-669.



Fig 9 Lateral view of the lumbar vertebrae five years after the first examination. The vertebral bodies are ivory like in density. The vertebral contours and intervertebral spaces are normal.

- (5) FRAENKEL E. Lymphomatosis granulomatosa. *Henke Lubarsch Handbuch d Spez path Anat u Hist* 1926 Vol I Part I 349.
- (6) HEUCK G. Zwei Fälle von Leukämie mit eigenem tumefizierten Blut—bzw Knochenmarks—befunden. *Virchow's Arch f path Anat* 1879 78, 475.
- (7) HIRSCH E F. Generalized Osteosclerosis with Chronic Polycythemia Vera. *Arch Path* January 1935 19, 91-97.
- (8) HULTÉN O. Ein Fall von Elfenbeinwirbel bei lymphogranulomatose. *Acta Radiol* 1927 8, 245.
- (9) JAFFE H L. Atypical Form of Paget's Disease Appearing as Generalized Osteosclerosis. *Arch Path* December 1933 16, 769-794.
- (10) LEDOUX LEBARD CHABANEIN and DESSANE. L'osteopoeclie forme nouvelle d'osteite condensante generalise sans symptomes cliniques. *Jour Radiol et d'electrol* 1916 2, 133.
- (11) MOLLER P F and GUDJOVSSON S V. Massive Fluorosis of Bones and Ligaments. *Acta radiol*, 1932 13, 269-294.
- (12) NUWERCK C and MORITZ P. Atypische Leukämie mit Osteosklerose. *Deutsches Arch f klin Med* 1905 84, 558.
- (13) OVERGAARD K. Ein Fall von osteosklerotischer Anämie. *Acta radiol* 1936 17, 51-67.
- (14) REICHE F. Aleukämische Myelose und osteosklerose. *Med Klin* 1927 23, 981-983.
- (15) RENDICH R A and SHAPIRO A V. Osteitis condensans ili. *Jour Bone and Joint Surg* October 1936 18, 899-908.
- (16) SICARD GALLI and HAGUENAU. Osteites condensantes a etiologie inconnue. *Jour Radiol et d'electrol* 1926 10, 503.

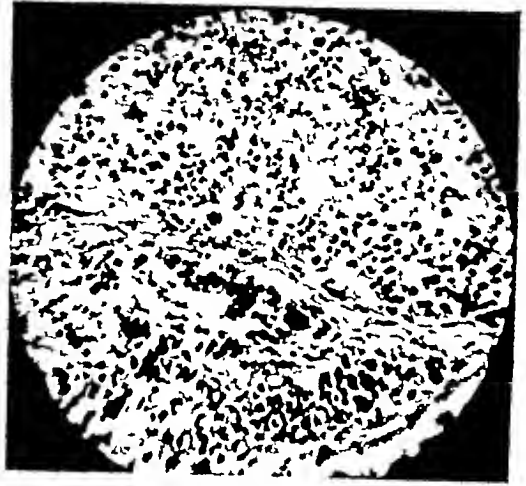


Fig 6 Case 1 Photomicrograph of section from inguinal lymph node

cases, May 23, 1932, reported "hereditary deforming chondrodystrophy." The opinion rendered on subsequent roentgenograms, dated April 24, 1933, was that of Ollier's disease. On Feb 19, 1934, the child developed enlarged cervical glands. X-ray treatments were given over the neck area at St Mary's Hospital, Brooklyn, in fractional doses over a period of one month to reduce the size of these glands, and also for possible beneficial effect on the bony lesions in the right leg if the same was caused by hyperparathyroidism. Soon thereafter, the child was under observation at the House of St Giles the Cripple, at which institution a diagnosis of congenital hypertrophy of the right leg was made. Abdominal examination at that time did not reveal any palpable masses or enlarged liver or spleen. On April 15, 1935, patient had the first attack of abdominal pain with vomiting.

Present Complaint—Recurrence of pain in abdomen, with vomiting for past four days.

Physical Examination—Well nourished pale looking child. Head, nose, ears and throat essentially negative. Glands in neck slightly enlarged. Chest negative. Abdomen showed bulging in left upper quadrant. No rigidity or tenderness present. A mass the size of a grapefruit

pathetic nervous system, somewhat larger than a lymphocyte, with a densely chromatic nucleus, and a narrow rim of cytoplasm. The

Clinical Picture—Neuroblastoma generally occurs during infancy or childhood and is exceedingly malignant. In the

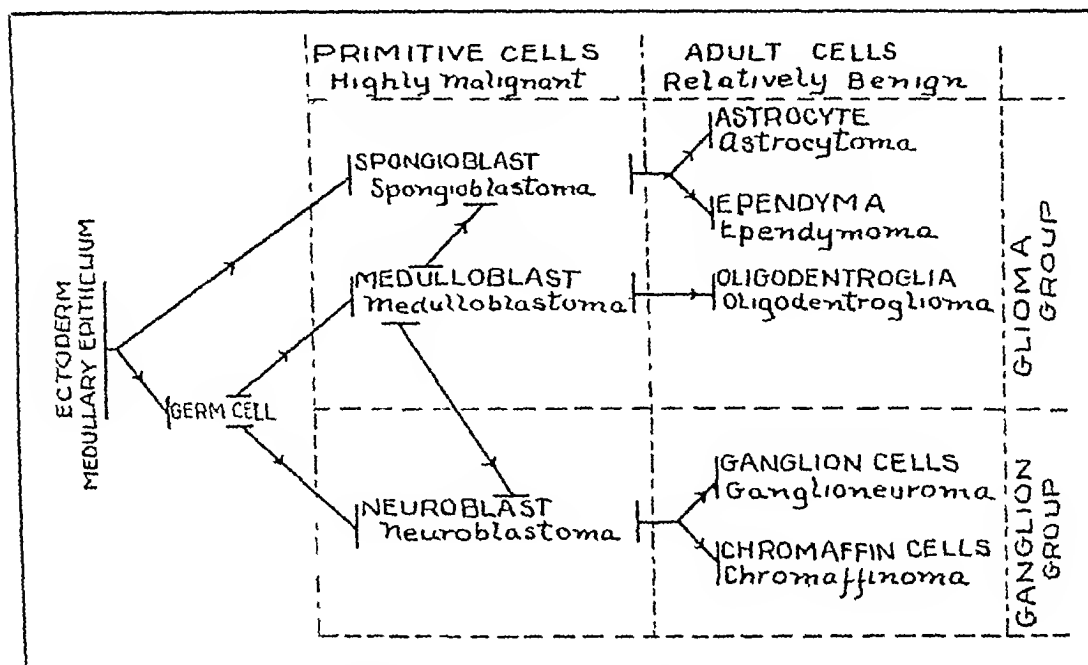


Fig 1 Schematic chart of cellular development of nervous system and the type of tumor derived from each of these cells

matrix in which the cells rest contains delicate fibrillæ which do not take the stain of connective tissue, collagen, or neuroglia. They are probably primitive axis cylinders. The cells often assume a roughly circular formation about a bundle of fibrillæ. These characteristic tumor 'rosettes' are found in the primary tumor but not usually in the metastasis."

It must be remembered that in the biopsy study, rosettes are seen only in the minority of cases. Lewis and Geschickter (16), in their study of 40 cases, reported the presence of rosette formation in only one-third of their group. In the absence of rosettes, an absolute diagnosis from the pathologic specimen alone is often exceedingly difficult and occasionally impossible. Rypins (20) emphasizes the fact that since the characteristic finding is a small round cell, highly undifferentiated, with a considerable amount of fibrillar material, the condition is often confused with Ewing's tumor and other highly undifferentiated neoplasms.

adult it is extremely rare. Ritter (19) has reported two cases in persons past middle age, occurring in the intestines, with metastasis to the adjacent mesenteric lymph nodes. Both cases, however, were of relatively benign character. Boyd (2) believes a diagnosis of neuroblastoma in an adult is an extremely risky one.

With the publication of an article by Pepper (18), in 1901, and one by Hutchinson (8), in 1907, each describing a different clinical manifestation of this disease, two types have since been universally accepted, each named after the respective author. In the Pepper syndrome, the tumor starts in the suprarenal, more frequently on the right side, with metastasis to the liver and adjacent lymph nodes. The liver may become so enlarged as to fill the greater part of the abdomen, usually not associated with any jaundice. In the Hutchinson type, there occurs metastasis to the skull, particularly the or-

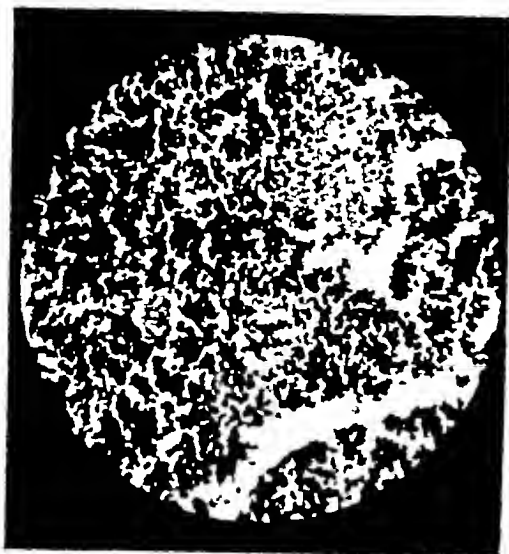


Fig 11 Case 2 Photomicrograph of section from suprarenal tumor tissue

Pathologic Report—"Specimen consists of a cystic mass 12 cm in diameter. External surface is mottled pearly white and red, rough, slightly lobulated. On section, some of the wall is thinned, but for the most part it is thickened and lined by soft reddish-brown papillomatous material, and some rather fresh blood clot. Microscopic examination [Fig 11] shows a small amount of loose fibrous tissue stroma to which is attached a tissue composed of a small amount of very fine reticulum supporting numerous small columnar-like cells. This tissue is permeated by numerous delicate blood vessels from the walls of which many of these cells assume a radial disposition. The cells are uniform in size and shape. There are also areas of necrosis and of extensive hemorrhage. An occasional arrangement suggesting rosette formation is seen. Diagnosis neuroblastoma."—M. Lederer, M.D.

The patient died on the day after the operation.

DISCUSSION

Case 1 It is interesting to note that the primary lesion was in the upper sympathetic ganglia, instead of the more common suprarenal site. Clinically there were no orbital findings such as ecchymosis or unilateral exophthalmos, as is generally seen in the Hutchinson type. The skeletal changes, particularly in the frontal region of the vault of the skull, were sufficient to

warrant one in making a roentgenographic diagnosis of "probable neuroblastoma."

Case 2 It is difficult to associate the unilateral skeletal pathology in the right scapula, right hand, right tibia, and right eleventh rib with that of neuroblastoma. The osseous lesions were first discovered three years prior to the disclosure of the suprarenal tumor. Because of the slow growing character of the skeletal changes, one is inclined to believe that the osseous pathology was independent of the neuroblastoma in the suprarenal and that we were dealing with a case of osteodystrophia fibrosa unilateralis, rather than bone metastasis. Unfortunately, no biopsy was obtained of any of the bone lesions.

SUMMARY

1 We have reviewed the embryology, pathology, clinical picture, roentgen findings, and radio-responsiveness of neuroblastoma.

2 Two cases of neuroblastoma have been presented, one in which the primary lesion was located in the upper sympathetic ganglion, and the other in the suprarenal gland.

I. S. S. 40—16 Gleane St., Boro of Queens, N. Y.
J. A. 946 Bushwick Ave., Boro of Brooklyn, N. Y.

REFERENCES

- (1) BAILEY and CUSHING. A Classification of the Tumors of the Ghoma Group on Histogenetic Basis. Lippincott Philadelphia 1926.
- (2) BOYD WILLIAM. Pathology of Internal Diseases. Lea & Febiger 1935 second ed. pp 489-836.
- (3) GESCHICKTER C. F. and COPLAND M. M. Tumors of Bone. Am Jour Cancer 1936 p 808.
- (4) GIBSON T. E. The Diagnosis of Adrenal Tumors, with Classification of the Adrenal Tumor Syndromes and Report of Cases. Jour Urol, 1927, 18, 33-59.
- (5) HAUSER, H. Radiosensitive Neuroblastoma. Am Jour Roentgenol and Rad Ther, February, 1934 31, 234-237.
- (6) HENLE CARVE-BELLE. Roentgen Findings in Neuroblastoma. Am Jour Roentgenol, and Rad. Ther November 1928, 20, 414-419.
- (7) HOLMES G. W. and DRESSER R. Roentgenologic Observation in Neuroblastoma. Jour Am Med Assn Oct. 27, 1928 91, 1246-1248.
- (8) HUTCHINSON R. On Suprarenal Sarcoma in Children with Metastasis in the Skull. Quart Jour Med, 1907-1908 1, 33-38.
- (9) KARELITZ S. Unusual Forms of Periosteal Elevation. Am Jour Dis Child 1927 33, 394-403.
- (10) KWARTEN B. and TWISS J. R. Malignant Neuroblastoma. Am Jour Dis Child 1927 34, 61-71.



Fig 3 Case 1 (Left) Pin hole shadow in frontal region of skull with widening of coronal suture (Right) Frontal area magnified for better visualization of minute osteoporotic shadows

(7) have used radiation therapy in their cases and found that the reaction did not alter the progress of the disease. Gibson (4) states that in inoperable cases, deep roentgen-ray therapy deserves a trial although no statistics are available as to its efficiency. Hauser (5) reports a case which was radioresponsive although only temporarily so. Only x-ray therapy was utilized by us in the two cases recorded in this paper but with very little effect. Apparently the character of response of neuroblastoma metastasis to radiation is similar to that of carcinoma metastasis.

CASE REPORTS

Case 1 D M, colored, aged 3, admitted on Dec 10, 1935, to the Queensboro Contagion Hospital as a suspected poliomyelitis. The onset had been insidious, dating back approximately four months prior to admission. There was complete loss of sensation and paralysis was present below the level of the fifth dorsal vertebra. The liver and spleen were not palpable, but the abdomen was moderately distended with gas and sensitive to palpation. Temperature was 104° at the time of admission. X-ray examination of chest (Fig 2) disclosed a large globular, partly calcified tumor mass in the right upper lobe. It was then considered highly prob-

able that the paralysis of the lower extremities was being caused by pressure on the cord by tumor tissue. A tentative diagnosis of transverse myelitis was made, and the patient transferred to the Queens General Hospital.

All of the osseous structures were then x-rayed. The skull disclosed (Fig 3) pin-hole vacuolated areas in the vault, chiefly in the frontal region. The coronal suture was separated. The long bones (Fig 4) showed poorly demarcated osteolytic areas, intramedullary in situation. The areas of bone destruction were larger in the pelvic bones (Fig 5-A). The only sign of periosteal reaction in the long bones was located in the distal fourth of the shaft of the left femur at the external margin (Fig 5-B). Roentgenologically a diagnosis of "probable neuroblastoma" was made.

Blood Study—Urea nitrogen, 60.3 mgm, cholesterol, 312 mgm, Wassermann and Kline tests negative. Blood culture positive for *Staphylococcus albus*. Hemoglobin, 30 per cent, red blood corpuscles, 2,290,500, white blood corpuscles, 7,520, 61 per cent polymorphonuclears, 32 per cent lymphocytes, 6 per cent monocytes, 1 per cent eosinophiles.

Urine Examination—Negative except for trace of albumin.

CASE REPORTS AND NEW DEVICES

ROTARY STORAGE CONTAINER FOR RADON GLASS CAPILLARIES¹

By CARL B BRAESTRUP and F SELLMER,
New York City

From the Physical Laboratory, Division of
Cancer, Department of Hospitals

In the Department of Hospitals of the City
of New York the emanation plant at the Cancer
Institute supplies all the radon for the various



Fig 1 Photograph showing unloading of container (actually there is a one inch lead screen between the container and technician)

municipal hospitals. Since a great variety of radon applicators are used, it necessitates keeping in stock an ample supply of radon glass capillaries.

In order to protect the radium technicians against stray radiation from the radon in stock, we developed a rotary storage container for the glass capillaries. In the design of this container we had three objects in mind: first, to completely surround the radon tubes with several centimeters of lead; secondly, to reduce the handling of the bare glass tubes to a minimum; and lastly, to develop a method whereby the fragile capillaries were not broken in the process of loading and unloading. The last objective presented the greatest difficulties, but these were finally overcome and the container described herein now has been used for

more than a year with no breakage whatsoever.

In Figure 2 is shown a cross section through the container. Mounted on a vertical shaft is a brass enclosed cylindrical lead disk provided with 35 compartments, each 32 mm long and 3 mm in diameter. The disk, which is mounted in a lead-lined brass casing, can be rotated around its axis by means of the handle. In the top of the casing is a hole with a funnel through which the capillary tubes may slide into the compartments. By shifting the position of the disk, each radon tube is loaded into a separate compartment, the number of which is indicated on a dial at the top.

Each compartment is provided with a trap door at the bottom. This door is normally closed, but may be opened by a lever when the compartment is above the receptacle used in transferring the radon tube to the measuring device or loading table.

In addition to the lead of the container, further protection against stray radiation is obtained by means of a one-inch screen placed between the operators and the container. The device, including the lead screen, is mounted on a truck and may be moved into whichever room it is to be used.

The container is first loaded in the pump room with a capillary just removed from the pump and suitably subdivided, each section being placed in a separate compartment.

The device is later rolled into the measuring room, where each glass tube is temporarily removed from the container to determine its value in millicuries. A record is kept of each capillary, giving the number of millicuries, time of measurement, and the number of its compartment.

The device is finally placed next to the loading bench, where the technician inserts the glass tubes into the various forms of applicators. In selecting the capillary, he consults the above-mentioned record, making correction for the decay of the radon.

To ascertain the amount of stray radiation received by the technicians, we made a series of ionization measurements, using average working conditions.

With nine radon capillaries having a total strength of 174 millicuries, the stray radiation was less than 0.009 r/min at 30 cm distance from the center of the container. The calibration of the ionization chamber was obtained by using a 1.98 mg Ra standard at a distance of one meter. The conversion to roentgens was made by assuming 1 gm minute = 132 r at a distance of 1 cm, using a filtration of 0.5 mm Pt. This value checks closely with that ob-

¹ Received for publication March 2 1937

ture varying between 98.8 and 106.4 degrees. The pulse range was between 100 and 140, and respirations between 24 and

is an area quite large and hyperchromatic. Definite extension into lymphatic and vascular channels is evident. Some cells

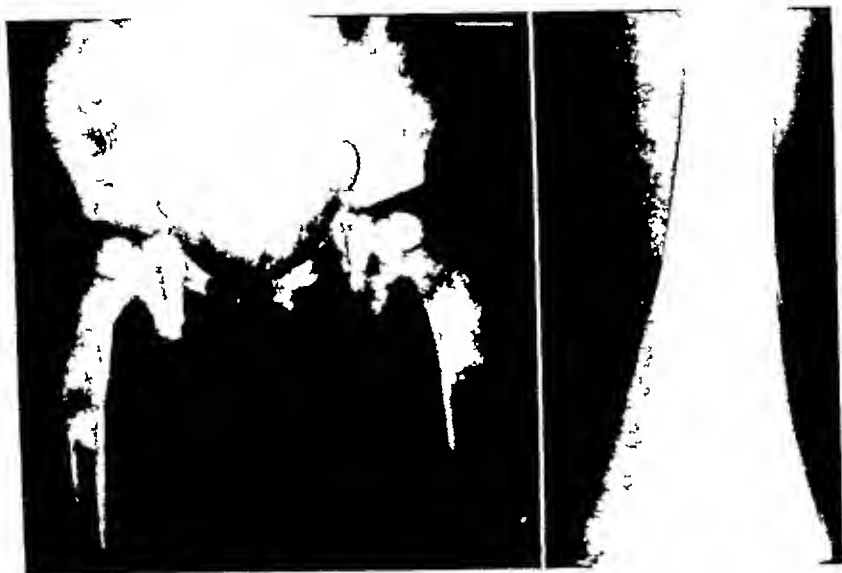


Fig 5 Case 1 (Left) Large poorly demarcated osteolytic areas in pelvis and upper femora (Right) Periosteal elevation (magnified) at margin of lower femur

48 On January 21, a transfusion of 100 cc was given. The patient died on January 27.

Postmortem Record—Autopsy Jan 27, 1936. Pathologists, Dr Santora and Dr Davidson. Limited examination only.

Anatomical Diagnosis

- 1 Neuroblastoma of upper sympathetic ganglion, with
- 2 Massive metastasis to lymph nodes,
- 3 Metastasis to bone,
- 4 Extensive lymphatic and blood vessel permeation,
- 5 Transverse myelitis in cervical region by compression through vertebral bodies (clinical),
- 6 Cystitis,
- 7 Secondary anemia, marked,
- 8 Pulmonary edema, marked

Cause of Death—Neuroblastoma with extension and cord compression and terminal ascending infection.

Microscopic Examinations (tumor tissue)—Extensive necrosis and large groups of hyperchromatic cells with some fibrillar tissue. Most of the cells are small and rounded, with scant cytoplasm. There

show ganglion cellular characteristics with distinct nucleoli and considerable cytoplasm. Other cells show considerable lipid accumulation in the cytoplasm. A rare rosette structure can be made out. Bielschowsky stains show some cellular positive fibers in direct relationship to groups of cells. Fibers are prominent and numerous and suggest that the fibrillar background noted in the hematoxylin and eosin sections are in part neurofibrils.

No marked changes or significant findings disclosed in adrenals, kidneys, liver, or spleen.

Case 2 L F, aged three and one-half years, white female, admitted to Trinity Hospital on June 16, 1935, with chief complaints of (1) pain in the upper abdomen with vomiting of four days' duration, (2) mass in upper abdomen, (3) abnormal growth of right leg since infancy.

Past History—At the age of two months, the child had pyelitis. When five months old, her mother noticed that the baby's right ankle was "swollen." X-ray examination at the Hospital for Joint Dis-

ned to have the storage container remotely controlled, thereby reducing the stray radiation to a negligible amount

A "BITE-TYPE" SINUS-MASTOID HEAD REST

B. J. MARSHALL NEELY M.D., *Lincoln, Nebraska*

The purpose of this communication is to describe a simple and effective device which permits immobility and accurate position in radiographic study of the paranasal sinuses and mastoid processes. The principle of construction as used for sinus work, is two horizontal bakelite bars which are shaped so as to permit the jaw to clamp over them in both the Caldwell and Waters positions. The board is so built that it fits over an 8 X 10 inch cassette. The horizontal bars are fixed to two upright poles of the correct height to accommodate the mouth in both the Caldwell and Waters positions (Fig. 1). With a minimum of care in positioning the mouth on the bars the sagittal plane of the head is absolutely perpendicular to the plane of the film and it remains only for the tube to be centered in order to obtain perfect position. With the jaws clamped onto these bars it is almost impossible for motion to take place during the exposure. The principle of the mastoid rest is the same, namely, an upright or perpendicular piece which is attached to an adjustable horizontal bar. The upright piece may be moved along the horizontal bar to accommodate the various shapes of patients' heads. The horizontal bar swings from one half of the cassette to the other thereby permitting the exposure of both mastoids on one film (Fig. 2).

In the Waters position the lead cover is removed and the patient is instructed to bite

down onto the lower horizontal bar in such a way that the chin and tip of the nose touch the cassette. A piece of good bond paper is placed over the bar for sanitary purposes and between each patient the bar is washed with alcohol or removed and boiled if desired. With the head in this position the tube is tilted from 10 to 15 degrees toward the feet, depending somewhat on the shape of the patient's head, and the exposure to be made (Fig. 3). Since motion is almost impossible the length of exposure is not important and almost any desired combination of technical factors may be used. It is also possible to increase the anode-film distance if so desired.

In the Caldwell position the other half of the 8 X 10 cassette is used and again immobility is attained by means of another horizontal bar which is placed somewhat higher and more posteriorly. The tube is angled about 10 to 12 degrees in this position (Fig. 4).

After both exposures have been made the exposed portion of the film is covered and the mask removed. A flash exposure is then made with the number and name in place. The result is a good view of the paranasal sinuses in both the Waters and Caldwell positions on one 8 X 10 inch cassette (Fig. 5).

For study of the mastoids both the horizontal bars are removed and the single upright piece is placed. With the head in the true lateral position, as judged by the radiologist or technician, it is held thus by asking the patient to bite onto the upright bar. It is readily seen that, with the jaws tightly clamped it is impossible for the head to be in other than a perfectly parallel plane with the cassette. Rotation of the head is also impossible after the jaws have been properly placed. The tube is then angled 15 degrees toward the feet and face

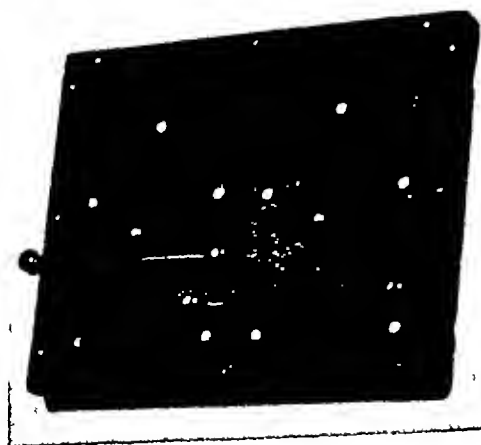


Fig. 1 Sinus board with cross bars in place for Waters and Caldwell positions



Fig. 2 Sinus bite mouth removed and perpendicular bite mouth in place for mastoids

ture varying between 98.8 and 106.4 degrees. The pulse range was between 100 and 140, and respirations between 24 and

is an area quite large and hyperchromatic. Definite extension into lymphatic and vascular channels is evident. Some cells



Fig 5 Case 1 (Left) Large poorly demarcated osteolytic areas in pelvis and upper femora (Right) Periosteal elevation (magnified) at margin of lower femur

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Fig 1

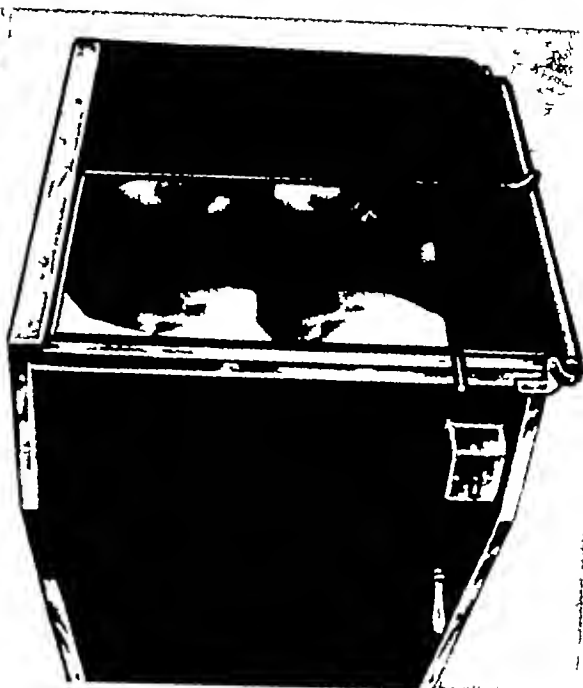


Fig 2

details becomes necessary, which demands an adaptation of the eye to the finer structure of the picture, in order to obtain an improved reading or interpretation of the film. In this respect, however, there seems to be much room for improvement, as the art of reading X-ray films is frequently not sufficiently supported by the technical devices used for their examination. And this is especially true when a case requires comparative study of various X-ray films taken at different times and under different conditions. In order to obtain maximum information from an X-ray film and to facilitate scientific interpretation, an X-ray illuminator of maximum efficiency is a prerequisite which ought to fulfill the following requirements:

- 1 Strongest possible source of light to illuminate even the darkest parts of an over-exposed film

- 2 Finest regulation down to almost complete darkness in order to study the thin and under-exposed negatives

- 3 Possibility to confine the field of view to any part of the film in order to obtain more contrast and to be able to concentrate on difficult structures

- 4 The illuminator must be arranged for greatest possible convenience of the examining physician. He must be able to relax completely and concentrate on the study of details of the film without undue tiring

- 5 It should be possible to make tracings of X-ray films (e.g., spine cases) and to take

measurements without having to fix the film with special gadgets

- 6 Furthermore the viewing box should be handy, it should fit into small space, it should be movable in order to be used in the operating and plaster room as well as at the bedside, and finally it should be reasonably priced

All these requirements are fulfilled by the viewing box (Figs 1 and 2), which has been built based upon many years of experience.

One of the most important principles used in this new device is characterized by the fact that the entire apparatus is arranged vertically, thereby permitting a considerable saving in space without sacrificing the large distance from the source of the light to the film which is necessary to preserve the films from overheating in using strong sources of light.

Figure 3 shows a front view, a plane view, and a vertical section through the device.

The illuminator has the form of a vertical column of about the height of a table.

The casing (1) is made of sheet metal provided with an insulating lining (2) of asbestos. Four castor wheels (3) ensure easy moving. The film support at the upper end of the casing consists of a horizontal light-diffusing glass plate (5) preferably of bluish color. The field of view can be confined variably by two self-rolling curtains (17 and 18).

An electric bulb (9) of 1,500 watts is arranged in the center of the bottom (4) giving

was palpable on the left side of the abdomen, extending from the costal margin to the level of the umbilicus. Liver not

palpable (Fig 8-B). There are also well demarcated areas of bone destruction with structural thickening of the proximal and

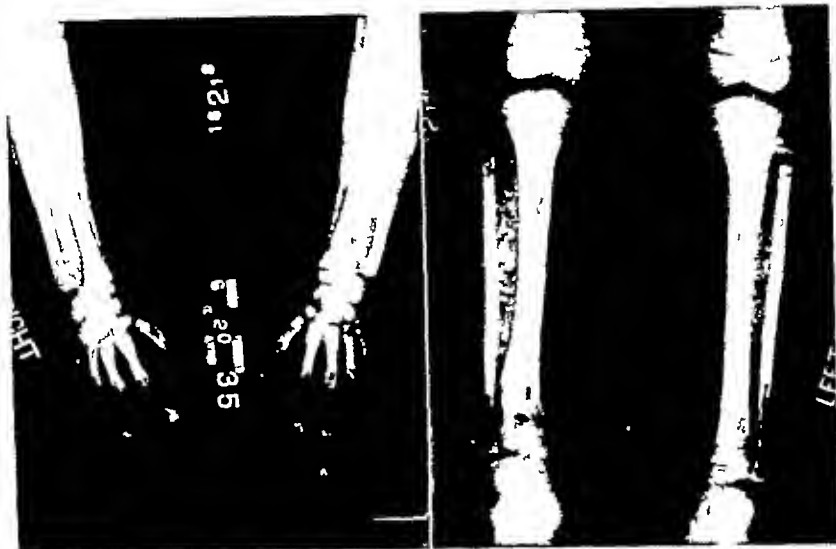


Fig 9 (Left) Case 2. Structural changes in phalanges of index and middle fingers and first and second metacarpal bones of right hand. Left hand negative.

Fig 10 (Right) Case 2. Right leg shows intramedullary osteoporosis of proximal and distal thirds of tibial diaphysis with structural enlargement of distal fourth of tibia. Left leg normal.

palpable. The right leg was enlarged, but no pitting, tenderness, nor sensory disturbances were disclosed. The middle and index fingers of the right hand were enlarged and somewhat deformed.

Blood Findings—Urea nitrogen, 13 mgm, cholesterol, 200 mgm, blood calcium, 12.5 mgm, blood phosphorus, 3.7 mgm, Wassermann and Mantoux tests negative, hemoglobin, 70 per cent, red blood corpuscles, 2,300,000, white blood corpuscles, 8,000, polymorphonuclears neut, 57 per cent, polymorphonuclears mature, 52 per cent, polymorphonuclears immature, 5 per cent, lymphocytes 43 per cent.

X-ray Findings—Examination of urinary tract (Fig 7) left side urography shows left kidney to be displaced downward and mesially by a tumor mass above, associated with flattening and distortion of its kidney pelvis and calices. Roentgenography of the skeletal structures discloses osteolytic changes within the inferior angle of the right scapula (Fig 8-A) and in the outer end of the right eleventh

rib (Fig 8-B). There are also well demarcated areas of bone destruction with structural thickening of the proximal and middle phalanges of the index finger and all of the phalanges of the middle finger and less conspicuous changes of similar character in the shafts of the first and second metacarpal bones, right hand (Fig 9). The right tibia (Fig 10) presents a few rather poorly demarcated intramedullary longitudinal areas of osteoporosis with structural enlargement in the lower third of its diaphysis and less pronounced intramedullary osteolytic changes in the upper third of the shaft. Skull findings are negative.

X-ray Therapy—One high voltage treatment given over left upper quadrant amounting to 200 r units. No beneficial effect noticed.

Operative Findings—A large suprarenal cystic tumor was present, which was dissected free and removed (July 17, 1935). Kidneys appeared normal. A few enlarged retroperitoneal glands were found. Liver, stomach, pancreas, and spleen were normal.

sufficient illumination for the study of even the darkest films

A heavy rheostat (11) controlled by a crank (12), the handle (13) of which projects outwardly through an arcuate slot (14) permits finest regulation of light from almost complete darkness to full power of 1,500 watts

The vertical arrangement of the apparatus provides sufficient distance between the strong source of light and the film and thereby prevents overheating of the film in spite of omission of special and complicated cooling devices

The location of the heavy rheostat in the lower half of the viewing box serves as a weight for stabilizing the device

The viewing box is about 90 cm high, the base is 37 X 37 cm, and the top is 52 X 52 cm

CONGENITAL CYSTIC DISEASE OF THE LUNG IN NEW-BORN INFANT¹

By IRANCES A. FORD M.D., *Detroit, Michigan*
Radiologist at Woman's Hospital

This report of a gradually expanding pulmonary cyst in a new-born infant diagnosed by roentgenologic examination and confirmed by autopsy findings, is presented to add to the increasing list of verified instances of congenital cystic disease of the lung

The pathologic basis of pulmonary cystic disease has been ably described by Koontz, and by King and Harris in recent medical literature, but the condition is sufficiently rare so that even some pathologists of wide experience have expressed doubts of its occurrence as a truly congenital malformation

Koontz believes that the cysts develop from occlusion of a portion of the bronchial tree during embryonic life, with subsequent expansion of the distal trunk by retained secretions. If the dilated terminal portion of the bronchus fails to rupture with establishment of respiration, a silent non-expansile structure remains. When communication between the cyst and the surrounding lung tissue does occur, various syndromes may develop, depending upon the freedom of ingress and egress of air

A full term, male infant was born by spontaneous delivery on Nov. 29, 1936. The child's color was blue at birth, but the respirations were regular and the cry vigorous. Labored respirations and cyanosis were first noted 24 hours later. Oxygen therapy relieved these symptoms for 12 hours. After that time shallow,



Fig. 1 Anteroposterior roentgenogram of the chest

rapid breathing and dusky color recurred in attacks of increasing frequency and severity in spite of continuous oxygen therapy and medication for cardiac and respiratory stimulation. Excess mucus was noted in the patient's throat at times. A slight bulging of the anterior chest wall was detected on the third day and this increased gradually to the time of death.

A roentgenogram of the chest made 72 hours after birth showed atelectasis of the left lung with displacement of the heart and mediastinum to the left. In the right thorax the intercostal spaces were widened and the right diaphragm was depressed. The over-distended right lung was divided into a number of large, irregular air spaces by thin partitions of the density of fibrous bands. At the periphery and base of the lung were small areas of increased density. There was no evidence of pneumothorax.

A diagnosis of congenital cystic disease of the right lung and atelectasis of the left lung, with displacement of the heart and mediastinum was made.

The infant died on the fifth day (102 hours after birth). An autopsy made by Dr. D. C. Beaver, pathologist at Woman's Hospital, within a few hours after death revealed the following data:

The only pathology of significance was in the thoracic cavity. The diaphragm was at the seventh rib on the left in the midclavicular line,

¹ This report is a preliminary contribution in a study of respiratory conditions in the newborn made possible by a grant from the Mendelsohn Fund, Detroit.

- (11) KLEIN, J Neuroblastoma of the Adrenal, with Multiple Metastases Am Jour Med Sci, October, 1932, 184, 491-494
 - (12) KÜSTER Ueber Glome der Nebennieren Virch Arch, 1905, 180, p 117
 - (13) LAPOINTE and LECÉNE Glome primitif de la capsule surénale Arch de Méd Exp 1907 19, 68
 - (14) LEDERER, M Neuroblastoma of the Adrenal Gland Jour Cancer Research, 1926, 10, 377-391
 - (15) LEWIS, D Tumors of the Sympathetic Nervous System Virginia Med Monthly, October, 1934, 61, 377-383
 - (16) LEWIS, D and GESCHICKTER, C F Tumors of the Sympathetic Nervous System Arch Surg, January, 1934, 28, 16-58
 - (17) MARCHAND Beiträge zur Kenntnis der Glandula Carotica und der Nebennieren Festschrift f R Virchow, 1891 1, 578
 - (18) PEPPER, W A Study of Congenital Sarcoma of Liver and Suprarenal Am Jour Med Sci, 1901, 121, 287
 - (19) RITTER, S A Neuroblastoma of the Intestine. Am Jour Path, 1925, 1, 519-526
 - (20) RYPINS E L Roentgen Diagnosis of Neuroblastoma in Children Am Jour Roentgenol and Rad Ther, 1937, 37, 325-332
 - (21) STURTEVANT, C N and KELLY, T C Neurocytoma of the Left Suprarenal Gland, with Metastasis to Liver Skull, and Bones Am Jour Dis Child, 1927, 33, 590-596
 - (22) TIDSWELL F and SEAR, H R Neuroblastoma Experiences at the Royal Alexandra Hospital for Children Sydney Australia New Zealand Jour Surg, April, 1933, 2, 360-380
 - (23) WRIGHT, J H Neurocytoma or Neuroblastoma A Kind of Tumor Not Generally Recognized Jour Exp Med, 1910 12, 556
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assistance of the nurse, I have strained my back severely, so the type of bed illustrated was invented

foot rests for an ordinary pelvic examination, although, of course, stirrups are used when radium is administered

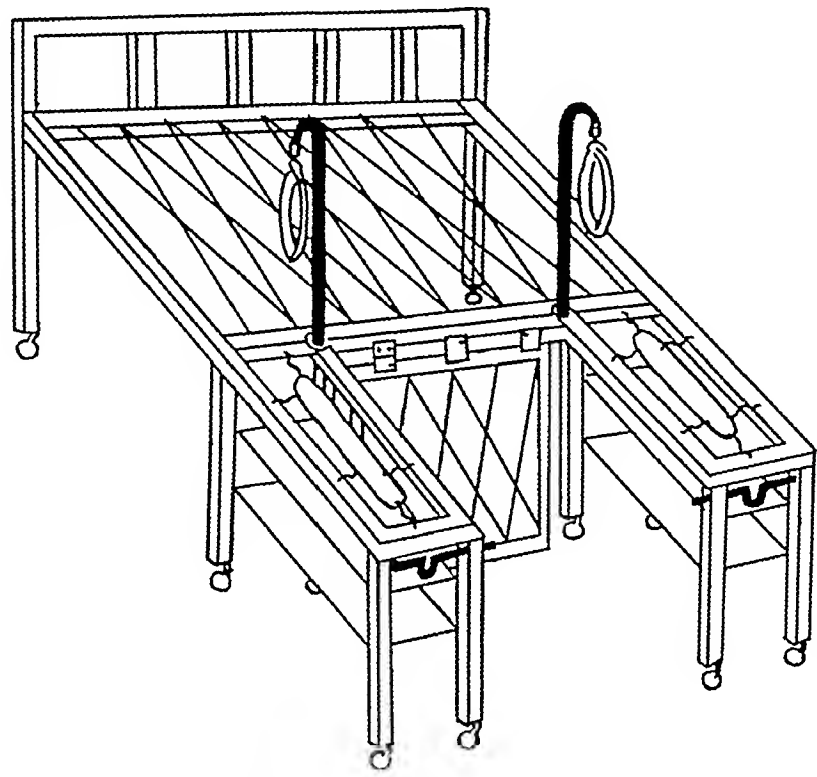


Fig 1

We had a local manufacturer of beds make this one. The footpiece is held up by two slide pins. The mattress is so divided that it folds down easily at the foot, leaving two lateral sections which are quite satisfactory for

This type of bed is also useful when, as in office buildings, conservation of space is necessary. When the footpiece is down, one has ample room for all necessary operative movements.

GENERALIZED OSSIFYING PERIOSTITIS¹

REPORT OF A CASE

By J N ODESSKY M D, and P A SHIRSHNEV M D, Moscow U S of S R

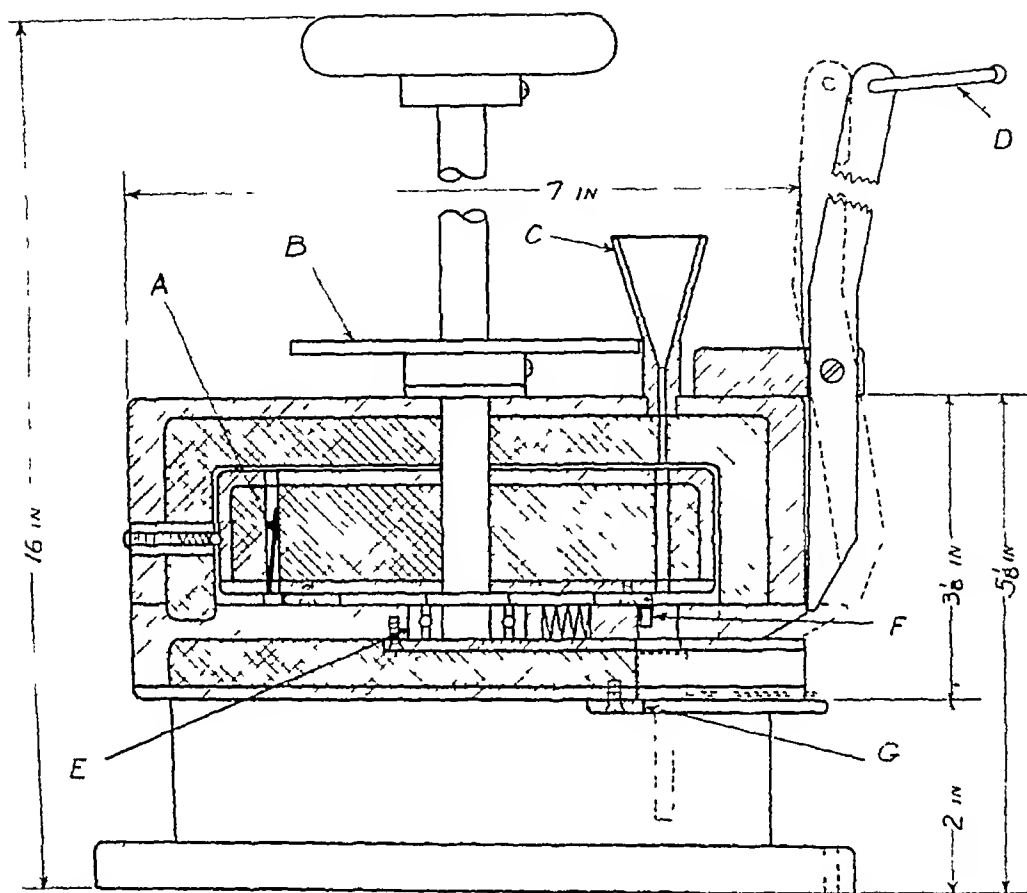
Patient S, male, 51 years of age, was admitted to the clinic on Dec 24, 1936 (History N 5855), complaining of dyspnea, palpitation of the heart on the slightest physical exertion, constant pain in the region of the heart, a cough with expectoration, and pain in the lower limbs.

¹From the Radiological Service of the Ostroumoff Clinical Hospital named after Prof A Zeitlin from the Department of Roentgenology (Director Prof A Zeitlin M D), and from the Propedeutic Clinic (Director Prof L Fogelson M D) of the Third Moscow State Medical Institute.

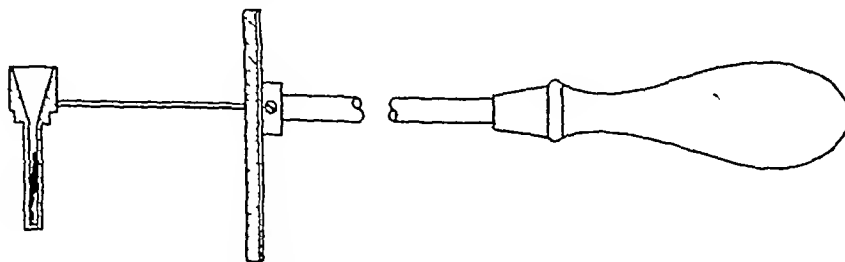
Two months earlier his illness began with a gradually increasing dyspnea and weakness. In February, 1936, he had fractured both bones of the right leg as the result of a fall. In October he noted the appearance of edema, first on one ankle than on the other and on the wrists.

Physical Examination—The patient was of middle height, of less than normal build, active. His skin was dry, with no eruptions. The movement of the joints was somewhat limited. The distal ends of the bones of the forearms and the lower limbs (Figs 1, 2, and 3) were markedly thickened, the finger tips were somewhat clubbed.

Percussion of the lungs revealed a hyper-resonance on both sides, with the exception of the region under the lower angle of the scapula.



ROTARY STORAGE SAFE
FOR GLASS CAPILLARY TUBES CONTAINING RADON



TOOL FOR HOLDING
RADON TUBES

Fig 2 Cross section through storage container. Symbols: A radon glass capillary, B dial with numbers for each compartment, C funnel, D lever for releasing trap door, E ball bearing, F, trap door, G guide and stop for radon tube holder.

tained by direct x-ray calibration against a standard chamber.

While the storage container in its present

form has reduced the stray radiation materially, further improvements are being considered. By rearranging the measuring room, it is plan-



Fig. 5

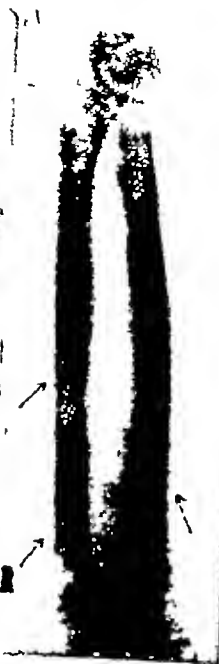


Fig. 6



Fig. 7

quantity of spirochetes, a few streptococci and Pfeiffer bacilli. No Koch bacilli or elastic fibers were found (after repeated examination). The Wassermann reaction was negative.

ROENTGENOGRAM OF THE CHEST

Dec. 29, 1936 The right upper lobe of the lungs was diffusely clouded, a more distinct shadow was apparent at the level of the third intercostal space. The rest of the lung was clear. The right hilus was more massive than the left. The broncho-vascular shadow was somewhat accentuated. The sinuses were free. The mobility of both diaphragmatic cupola was slight.

The roentgenologic examination of the heart revealed a slightly dilated left ventricle, the vascular shadow was somewhat lengthened and was wider than normal.

Jan. 15, 1937 The right upper lobe was clouded. A more compact shadow was seen between the second and third intercostal spaces, its character was not, however, quite homogeneous but there were intermittent clearer shadows. In the lower medial part these shadows touched the upper end of the right sinus.

Feb. 7, 1937 The diffuse heavy shadow of the upper lobe disappeared, leaving a clear picture of the lung, with the exception of the compact shadow in the central part, which remained unchanged.

March 7, 1937 The compact area in the lung on the level of the second and third intercostal spaces remained unchanged, but its character became more homogeneous (Fig. 4).

March 28, 1937 No changes from above noted in the roentgenograph.

ROENTGENOGRAMS OF THE UPPER LIMBS (FIGS. 5, 6)

On the diaphysis of both humeri was seen a periosteal deposit, more slight on the anterior and more compact on the posterior surface. In the proximal parts of both bones of the fore arm no changes were noted. The rest of the bones, along their entire length, were enveloped by periosteal deposits. Their contours were smooth in some places and serrated in others. In the metaphysis of the distal end of the radius, the periosteal growths were divided from the medullary layer by a lighter stratum. Beginning from the middle of the lateral part of the ulnar bone the periosteal layer widened toward the distal end, reaching 3 mm. in width. Also the diaphyses of the carpal bones, the basic and second phalanges were enveloped by periosteal deposits which were more accentuated on the first and fifth carpal, and second, third, and fourth basal phalanges.

The nail phalanges were unchanged. The joints were normal, the articular fissures were of normal width.

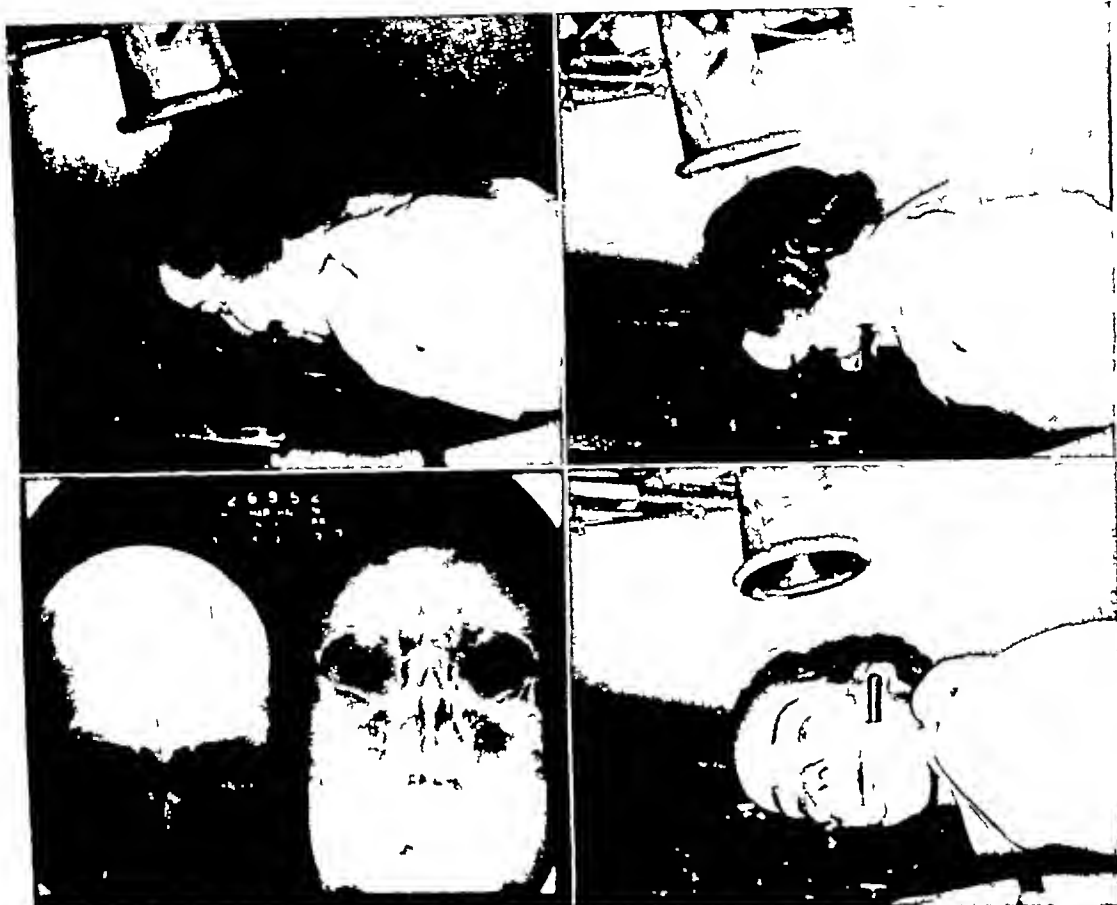


Fig 3 (upper left) Method of holding head in Waters position by means of "bite mouth" If desired, the nose may be elevated about 15 cm above the cassette and the tube left perpendicular

Fig 4 (upper right) Method of maintaining head in Caldwell position by means of "bite-mouth" Tube is angled about 10 to 12 degrees depending somewhat on the shape of the head

Fig 5 (lower left) Representative film made with "bite mouth" type of sinus head rest

Fig 6 (lower right) Showing application of "bite mouth" principle in maintaining head position for mastoids

in the usual manner and the exposure made. As in the case of the sinuses, it is almost impossible for motion to occur during an exposure, providing, of course, the patient maintains his hold on the perpendicular bar. For this reason the length of exposure need not be taken into consideration and any desired combination of technical factors may be used (Fig 6). The perpendicular bar is also used for lateral views of the frontal and sphenoid sinuses.

The same principle may be utilized for upright sinus films if attached to a suitable standard. A Lysholm grid may be used by simply inserting it between the cassette and the mask.

SUMMARY

In conclusion, a simple "bite mouth" combination sinus-mastoid board has been described which greatly facilitates good position and immobility.

I wish to thank Mr. Walter Ferris, of the National Manufacturing Company, for his helpful suggestions and for the construction of the "board."

A NEW DEVICE FOR READING X-RAY FILMS¹

By HENRY H. JORDAN, M.D., New York City

The constant improvement in the technique of roentgenography and the steady accumulation of case reports adding to our diagnostic experience ought to result in better X-ray interpretation. However, when more details are being reproduced by an X-ray film of higher sensitivity, a more intensive study of these

¹ U. S. Patent No. 2,079,373

of the above affections of the lungs are numerous but only few develop Pierre-Marie-Bamberger's disease. In more than twenty cases ossifying periostitis could not be regarded as a secondary manifestation since there was no preliminary disease to which it could be ascribed. Thus the etiologic factor remained in these cases unknown. The question was clarified neither by the work of Bamberger nor by the more recent reports of the American authors, Compere, Adairs, and Compere. These authors could not produce the process experimentally and came to the conclusion that the causative factor of this disease is yet unknown.

The symptoms presented by our patient could be summarized as follows: characteristic for the Marie-Bamberger's disease was the symmetrical enlarging of the upper and lower extremities with expressed clubbing of the

finger tips. Roentgenologically there were revealed periosteal deposits along the entire length of the long bones, also on the carpal, tarsal, and basal phalanges, with the exception of the nail phalanges. According to the literature these symptoms develop chronically and the patient cannot tell when the first signs of the disease appeared. However, there are cases in which the development of the symptoms proceeds rapidly and their onset can be revealed quite distinctly. To this latter group evidently belongs our patient. As noted above, three or four months previous to admittance into the clinic he noted an edema of the ankles and wrists. In our case were found definite pathologic changes in the lungs, but it would be incorrect to ascribe the development of the ossifying process to this lesion of the lungs since it might be an accidentally concurrent process.

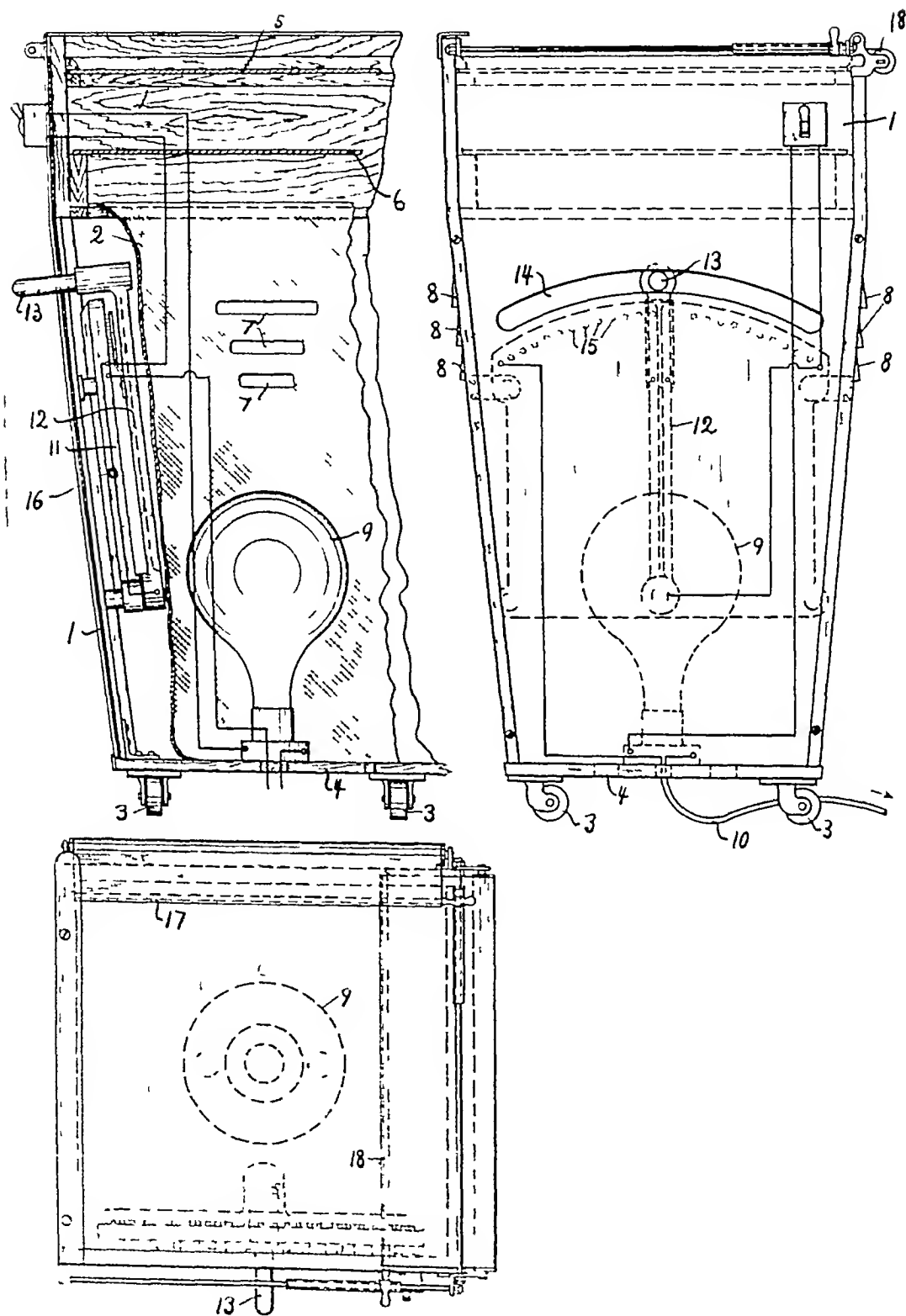


Fig 3

of the above affections of the lungs are numerous but only few develop Pierre-Marie-Bamberger's disease. In more than twenty cases ossifying periostitis could not be regarded as a secondary manifestation since there was no preliminary disease to which it could be ascribed. Thus the etiologic factor remained in these cases unknown. The question was clarified neither by the work of Bamberger nor by the more recent reports of the American authors, Compere, Adams, and Compere. These authors could not produce the process experimentally and came to the conclusion that the causative factor of this disease is yet unknown.

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Fig 2 The opened cyst ($3\frac{1}{2} \times 2\frac{1}{4} \times 1\frac{1}{2}$ inches)



Fig 3 Photomicrograph of the cyst wall ($\times 100$)

and within 0.5 centimeter of the costal margin on the right. The pleural cavities contained no free fluid nor adhesions. The heart was displaced into the left thoracic cavity but showed no abnormality. The aorta and pulmonary trunk were normal. The left lung was of increased consistency and microscopic sections revealed moderate atelectasis. Most of the right upper and middle lobes presented a similar appearance, but in addition small areas of crepitant tissue, pink in color, occurred mainly at the periphery of the lobes. These portions showed moderate emphysema, microscopically. The lower lobe of the right lung was greatly enlarged, measuring 11 by 7 by 5.5 centimeters. It was light pink in color, translucent, and presented the appearance of a thin-walled cavity filled with air. The lower or diaphragmatic surface showed small areas of lung tissue varying from dark red to pink color, with only the margins exhibiting crepitation. The dilated sac-like portion of the lung when opened was found to be a single air-filled space, lined with smooth, glistening, fibrous tissue, arranged in strands which partially divided the cavity. Microscopically, the wall consisted of a surface layer of moderately high bronchial type epithelium supported on a definite but variable connective tissue membrane. The adjacent alveolar spaces opened into the cyst as they normally do into the bronchi. The

lung tissue surrounding the cyst wall was normal, except for occasional large emphysematous spaces.

The trachea was normal, and a probe could be passed readily into the primary bronchus of the left lung, and into the upper and middle lobes on the right. A branch of the right lower bronchus, leading into the diaphragmatic portion of the lower lobe, was patent, but no macroscopic communication with the distended cyst could be found.

REFERENCES

- KOONTZ A. R. Congenital Cysts of the Lung. *Johns Hopkins Hosp Bull* 1925 37, 340-361.
 KING J. C., and HARRIS, L. C. Congenital Lung Cyst. *Jour Am Med Assn* 1937, 108, 274-280.

RADIUM BED

By S. S. MARCHBANKS M.D., *Chattanooga, Tenn.*

The idea for the construction of this bed with a hinged footpiece (Fig. 1) was mothered by necessity.

I administer radium to quite a number of cases of cancer of the uterine cervix in my office, having rooms for this purpose.

On two occasions, when lifting the patient back from the foot of the bed, even with the

132 Parkside Ave , Brooklyn Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society—President John Barnes, M D 875 Lafayette Ave , Vice president, W L Mattick M D , 290 Highland Drive, Secretary-Treasurer, J S Gian Franceschi, M D 610 Niagara Street Meetings second Monday evening each month

Central New York Roentgen-ray Society—President W E Achilles, M D 60 Seneca St., Geneva, Vice president, M T Powers, M D , 250 Genesee St., Utica, Secretary Treasurer, Carlton F Potter, M D., 425 Waverly Ave., Syracuse Meetings held in January May, and October as called by Executive Committee

Long Island Radiological Society—President David E Ehrlich, M D , 27 W 86th St , New York City Vice president, H Koiransky, M D , 43-37 47th St. Long Island City, Secretary, S Schenck M D , 115 Eastern Parkway, Brooklyn, Treasurer, Moses Goodman M D 45-01 Skillman Ave , Long Island City Meetings third Thursday evening each month at Kings County Medical Bldg

New York Roentgen Society—President, E F Merrill M D 30 W 59th St , New York City, Vice president I W Lewis, M D , Secretary, H K Taylor M D 607 Madison Ave , New York City, Treasurer R D Duckworth, M D 170 Maple Ave White Plains Meetings third Monday evening each month at Academy of Medicine

Rochester Roentgen ray Society—Chairman, Joseph H Green M D , 277 Alexander St , Secretary, S. C Davidson, M D , 277 Alexander St Meetings at convenience of committee

Society of Radiological Economics of New York—President, Albert L Voltz M D , 115-120 Myrtle Ave Richmond Hill, Vice-president, M M Pomeranz M D 911 Park Ave New York City, Secretary W F Francis, M D , Treasurer Theodore West M D , United Hospital Port Chester Meetings first Monday evening each month at McAlpin Hotel

NORTH CAROLINA

Radiological Society of North Carolina—President Robert P Noble M D , 127 W Hargett St , Raleigh, Vice president A L Daughtridge M D , 144 Coast Line St , Rocky Mount Secretary-Treasurer Major I Fleming M D , 404 Falls Road, Rocky Mount Meetings with State meeting in May and meeting in October

OHIO

Cleveland Radiological Society—President, North W Shetter M D Lakewood City Hospital Lakewood Vice-president John Heberding, M D , St Eliza-

where a diminution of resonance was noted. Auscultation showed a great number of dry sibilant sounds and a number of râles in the



Fig 1

region where percussion sound was dulled. The sputum was of muco-purulent character but without admixture of blood.

The Heart—The dullness extended to the left 1 cm. beyond the linea medio-clavicularis and to the right 1 cm. beyond the right sternal border. The tones of the heart were dull, no murmurs were heard. The blood pressure was 140/80.

Examination of the gastro-intestinal tract, kidneys, and nervous system showed no abnormalities.

Analysis of Urine—Color, yellowish, reaction, acid, specific gravity, 1.015. Under the microscope, a small number of leukocytes, epithelium, and mucus.

The blood count showed hemoglobin, 59 per cent, erythrocytes, 3,690,000, color index, 0.8, leukocytes, 11,600, neutrophils, 69 per cent, stablike, 8.5 per cent, lymphocytes, 17 per cent, and monocytes, 5 per cent. The erythrocyte sedimentation test was 35 mm. per hour (Panshenkoff apparatus). Examination of the sputum showed a few erythrocytes, quite a great



Fig 2



Fig 3



Fig 4

Sam W Donaldson, M D , 326 North Ingalls St , Ann Arbor, *Secretary Treasurer*, E R Witwer M D , Harper Hospital Meetings first Thursday of each month from October to May inclusive, at Wayne County Medical Society Bldg

Michigan Association of Roentgenologists — *President*, E R Witwer, M D , Harper Hospital, Detroit, *Vice president*, D W Patterson, M D , 622 Huron Street, Port Huron, *Secretary Treasurer* C K Husly M D 1420 David Whitney Bldg, Detroit

MINNESOTA

Minnesota Radiological Society — *President*, Walter H Ude, M D , 78 S 9th St , Minneapolis, *Vice president* Leo G Rigler M D , University Hospitals, Minneapolis, *Secretary-Treasurer*, Harry Weber, M D , 102 Second Ave S W , Rochester Meetings quarterly

MISSOURI

The Kansas City Radiological Society — *President*, L G Allen M D 907 N 7th St Kansas City, Mo , *Secretary*, Ira H Lockwood M D , 306 E 12th St , Kansas City Mo Meetings last Thursday of each month

The St Louis Society of Radiologists — *President*, Joseph C Peden, M D , 634 N Grand Blvd , *Secretary* W K Mueller, M D , 607 N Grand Blvd Meetings fourth Wednesday of each month

NEBRASKA

Nebraska Radiological Society — *President*, E W Rowe, M D 128 N 13th St , Lincoln, *Secretary*, D Arnold Dowell M D , 117 S 17th St , Omaha Meetings first Wednesday of each month at 6 P M in Omaha or Lincoln

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island) *President*, Frank E Wheatley M D , 520 Beacon St Boston, *Secretary* E C Vogt, M D , 300 Longwood Ave , Boston Meetings third Friday of each month from October to May inclusive, usually at Boston Medical Library

NEW HAMPSHIRE

See New England Roentgen Ray Society

NEW JERSEY

Radiological Society of New Jersey — *President*, J D Tidaback, M D , 382 Springfield, Summit, *Vice president*, Milton Friedman, M D Newark Beth Israel Hospital Newark, *Secretary*, P S Avery, M D , 546 Central Ave. Bound Brook Meetings at Atlantic City nt time of State Medical Society and Midwinter in Newark as called by president

NEW YORK

Brooklyn Roentgen Society — *President*, Albert Voltz, M D , 115-120 Myrtle Avenue, Richmond Hill, *Vice president*, A L L Bell, M D , Long Island College Hospital, Henry, Pacific and Amity Sts , Brooklyn *Secretary Treasurer*, E Mendelson M D

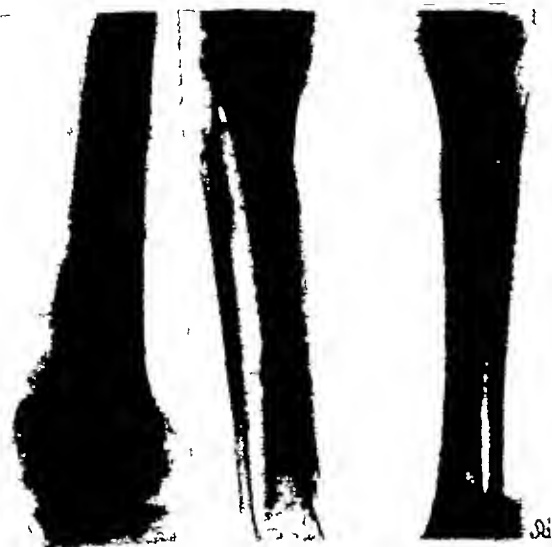


Fig 8

Fig 9



Fig 10

ROENTGENOGRAMS OF THE LOWER LIMBS (FIGS 7, 8, 9, 10)

Along the entire length of the femoral bones were noted periosteal growths. In the proximal end of the right femur, beginning from the trochanter major and reaching to the middle third of the bone, the periosteal deposit reached from 2 to 5 mm in width, and from the trochanter minor toward the lower third its width was equal to from 1 to 2 mm. On a limited area of about 4 cm on the margin of the middle and lower third of the femur the width of the periosteal layer reached even 6 mm. The medullary layer was quite distinctly seen. The hip and knee joints revealed no changes. The articular fissure was normal. On the left leg the periosteal layer on the exterior surface along the entire length of the fibula reached from 1 to 2 mm in width, on the interior surface it was noted only on the lower half of the bone. The contours were serrated. The upper two-thirds of the lateral surface of the tibia and the lower two thirds of its medial surface had periosteal deposits from 2 to 5 mm wide. They presented a jagged appearance on the exterior surface and were smooth on the interior surface.

The right leg showed an old fracture of the upper third of the fibula and lower third of the tibia. There were also noted considerable periosteal growths along both bones with the exception of the inferior surface of the metaphysical part of the proximal end of the tibia. The entire surface of the periosteal deposit was serrated. Its width reached about 6 mm.

The bones of the feet showed periosteal growths clearly expressed along the diaphyses

of all the bones of the metatarsus and basal phalanges, the jagged character of the contours was accentuated. The nail phalanges remained unchanged. The ankle joints were normal, the articular fissures were of normal width. The bones presented a porous appearance.

DIAGNOSIS

Pierre-Marie-Bamberger's disease (generalized ossifying periostitis), right-sided catarrhal pneumonia, cardiosclerosis.

DISCUSSION

Cases of generalized ossifying periostitis of the long bones are quite rare. In the world literature there appeared descriptions of about 175 cases during the period of fifty years, of which only about 30 cases have had histologic investigations.

However, there is no unity on the concept of pathogenesis of the disease. Most authors agree that ossifying periostitis is a secondary disease and not a disease *sui generis*, since it might appear in the course of various chest affections, such as tuberculosis, pneumonia, empyema, abscesses, bronchiectasis, malignant tumors (original and of metastatic origin), blastomycosis, cardiac diseases, etc. This leads one to the belief that the development of an ossifying periostitis may depend upon pathologic changes in the lungs. However, the question whether all the above-mentioned diseases of the lungs may really be held responsible for the appearance of this disease is still open. Patients suffering from one or another

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

EARLY DIAGNOSIS OF BREAST CARCINOMA

It is the experience of physicians that too large a number of breast cancer cases are advanced when treated. There are many reasons for this, but the most important one is that a diagnosis is not made in the early stages of the disease. We so often hear physicians admonish women to be on their guard for cancer of the breast, and if they observe a lump in the breast, to go immediately to their physician. When a lump in the breast is discovered, if it is cancer, it is usually no longer considered an early case.

From one of our largest medical centers are reported certain statistics to the effect that from 35 to 50 per cent of cancers of the breast are inoperable when first seen, and 62 per cent of cancers of the breast have already metastasized when first seen.

For this reason, efforts have been made to diagnose carcinoma of the breast in its earliest stage, even in its pre-cancerous stage. Pre-cancerous conditions such as papillomas, Paget's disease of the nipple, and Schimmelbusch's

disease, if diagnosed early and properly treated, may be the means of saving many cases from developing cancer, and in this manner the mortality rate will be appreciably diminished.

In appreciation of their importance, many different methods of examination have been employed, all of which have been found of value, either singly or in combination. For a long time dependence for the diagnosis of such cases has been placed upon transillumination. By this means it is possible, at times, when employed by competent hands, to differentiate between cysts containing clear fluid and solid tumors. It is helpful in the diagnosis of hematomas of the breast following trauma, and also in helping to localize duct papillomas. However, it has its limitations, for instance, it is not of much value in differentiating between benign and malignant solid tumors such as fibroadenoma and carcinoma. While this type of examination in the hands of the experienced physician is of importance, frequently in diagnosing pre-cancerous and early cancer of the

HOWARD P. DOUB, M.D.

It has become a pleasant custom for readers to find, each year, in RADIOLOGY, a portrait of the President of the Radiological Society of North America. This year especial significance is added by the fact that the President is also the Associate Editor of the Journal.

Howard P. Doub was born in Hagerstown, Maryland, in 1890. He took his A.B. degree at Western Maryland College, later graduating in medicine from Johns Hopkins University, Baltimore. He is Radiologist at the splendid Henry Ford Hospital, in Detroit. He is a member of the American Roentgen Ray Society, the American Radium Society, the College of Radiology, a Fellow of the American Medical Association, and a diplomate of the American

Board of Radiology, among other medical society affiliations.

Since the Society founded its present Journal, RADIOLOGY, Dr. Doub has been a contributor to, and through the years he has evidenced deep interest in its progress. He has a marked faculty for calmly judging all phases of a question before he speaks concerning it.

Dr. Doub has held office in the Society as Chairman of the Executive and Publication committees and as member of various other committees, so that he was intimately acquainted with its development and business affairs when he was chosen for its presidency. He is thoroughly respected as a scientist, well liked as an individual, and the Society has honored itself in the choice of Howard P. Doub for President.

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

CALENDAR

Editor's Note—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section

CALIFORNIA

California Medical Association, Section on Radiology—*Chairman*, John D Lawson, M D 1306 California State Bldg, Sacramento, *Secretary*, Karl M Bonoff, M D, 1930 Wilshire Blvd Los Angeles Meets annually with California Medical Association

Los Angeles County Medical Association Radiological Section—*President*, John F Chapman M D, 65 N Madison Ave, Pasadena, *Vice-president*, E N Liljedahl, M D 1241 Shatto St, *Secretary*, Merl L Pindell, M D 678 South Ferris Ave *Treasurer* Henry Snure, M D 1414 Hope Street Meets every second Wednesday of month at County Society Building

Pacific Roentgen Club—*Chairman*, Raymond G Taylor M D, 1212 Shatto St, Los Angeles, *Secretary* L Henry Garland M D, 450 Sutter St San Francisco

San Francisco Radiological Society—*Secretary* L H Garland M D, 450 Sutter Street Meets monthly on first Monday at 7 45 P M, alternately at Toland Hall and Lane Hall

COLORADO

Denver Radiological Club—*President* John S Bouslog, M D, 246 Metropolitan Bldg, *Vice-president*, Sanford Withers M D, 304 Republic Bldg, *Secretary* Ernst A Schmidt M D Colorado General Hospital, *Treasurer* H P Brandenburg M D 155 Metropolitan Bldg Meets third Tuesday of each month at homes of members

CONNECTICUT

Connecticut State Medical Society Section on Radiology—*Chairman* Kenneth K Kinney, M D 29 North Street Willimantic, *Vice chairman*, Francis M Dunn M D 100 State Street New London *Secretary Treasurer*, Max Cluwan M D, 242 Trumbull St Hartford Meetings twice annually in May and September

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society

FLORIDA

Florida State Radiological Society—*President* Gerald Ripap M D 168 S E 11st St Miami, *Vice presi-*

dent, H O Brown, M D, 404 First Nat'l Bank Bldg, Tampa, *Secretary Treasurer*, H B McEuen, M D, 126 W Adams St, Jacksonville

GEORGIA

Georgia Radiological Society—*President*, James J Clark, M D, Doctors Bldg, Atlanta, *Vice president*, William F Lake, M D, Medical Arts Bldg, Atlanta, *Secretary-Treasurer*, Robert C Pendergrass, M D, Prather Clinic, Americus Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring

ILLINOIS

Chicago Roentgen Society—*President*, David S Beilin, M D, 411 Garfield Ave, *Vice-president*, Chester J Challenger, M D, 3117 Logan Blvd, *Secretary-Treasurer*, Roe J Maier, M D, 7752 Halsted St Meets second Thursday of each month, September to May, except December

Illinois Radiological Society—*President*, Ivan Brouse, M D, 316 W State, Jacksonville, *Vice-president*, Cesar Gianturco, M D, Carle Hospital Clinic, Urbana, *Secretary Treasurer*, Edmund P Halley, M D, 968 Citizens Bldg, Decatur Meetings quarterly by announcement

Illinois State Medical Society, Section of Radiology—*President*, Roswell T Pettit, M D, 728 Columbus St, Ottawa, *Secretary*, Ralph G Willy, M D, 1138 N Leavitt St, Chicago

INDIANA

Indiana Roentgen Society—*President* J N Collins, M D, 23 E Ohio St, Indianapolis *President-elect*, Stanley Clark, M D, 108 N Main St., South Bend, *Vice-president*, Juan Rodriguez, M D, 2903 Fairfield Ave., Fort Wayne, *Secretary-Treasurer*, Clifford C Taylor, M D, 23 E Ohio St, Indianapolis Annual meeting in May

IOWA

The Iowa X-ray Club—Holds luncheon and business meeting during annual session of Iowa State Medical Society

MAINE

See New England Roentgen Ray Society

MARYLAND

Baltimore City Medical Society, Radiological Section—*Chairman* Marcus Ostro, M D 1810 Eutaw Place, *Secretary*, H E Wright, M D 101 W Read St Baltimore Meetings second Tuesday of each month

MASSACHUSETTS

See New England Roentgen Ray Society

MICHIGAN

Detroit X ray and Radium Society—*President* L W Hall M D 10 Petcboro Street, *Vice president*,

beth's Hospital, Youngstown, *Secretary-Treasurer* Harry Hauser, M D, Cleveland City Hospital, Cleveland Meetings at 6 30 P M at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists)—*President*, George Benzing, M D, St Elizabeth Hospital, Covington, Ky, *Secretary-Treasurer*, Justin E McCarthy, M D, 707 Race St, Cincinnati Ohio Meetings held third Tuesday of each month

PENNSYLVANIA

Pennsylvania Radiological Society—*President*, Sydney J Hawley, M D, Geisinger Memorial Hospital Danville, *First Vice-president*, William J McGregor M D 744 Franklin Ave Wilkesburg, *Second Vice-president*, Oscar M Weaver, M D, 12 S Main St, Lewistown, *Secretary-Treasurer*, Lloyd E Wurster, M D, 416 Pine St, Williamsport, *President elect* Charles S Caldwell, M D, 520 S Aiken Ave, Pittsburgh Annual meeting May, 1938 Exact date and place to be decided

Philadelphia Roentgen Ray Society—*President* Thomas P Laughery, M D, Germantown Hospital, *Vice-president*, Elwood E Downs, M D Jeans Hospital, Fox Chase, *Secretary*, Barton H Young, M D, Temple University Hospital, *Treasurer*, R Manges Smith M D, Jefferson Hospital Meetings first Thursday of each month from October to May Thompson Hall College of Physicians, 19 S 22nd St 8 15 P M

The Pittsburgh Roentgen Society—*President*, F L Schumacher, M D, Jenkins Arcade, *Secretary*, H N Mawhunny, M D, Mercy Hospital Two Fall and two Spring meetings at time and place designated by president

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

South Carolina X-ray Society—*President*, Robert B Taft, M D, 105 Rutledge Ave, Charleston, *Secretary-Treasurer* Hillyer Rudisill, M D Roper Hospital Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association

SOUTH DAKOTA

Meets with Minnesota Radiological Society

TENNESSEE

Memphis Roentgen Club—Chairmanship rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

Tennessee State Radiological Society—*President*, H S Shoulders, M D 246 Doctors Bldg, Nashville, *Vice-president*, S S Marchbanks, M D, 508 Medical Arts Bldg, Chattanooga, *Secretary-Treasurer*, Franklin B Bogart, M D, 311 Medical Arts Bldg, Chattanooga Meeting annually with State Medical Society in April

VERMONT

See New England Roentgen Ray Society

VIRGINIA

Radiological Society of Virginia—*President*, Fred M Hodges, M D, 100 W Franklin St, Richmond, *Vice-president*, L F Magruder M D, Raleigh and College Aves, Norfolk, *Secretary*, V W Archer, M D University of Virginia Hospital Charlottesville

WASHINGTON

Washington State Radiological Society—*President*, H E Nichols, M D, Stimson Bldg, Seattle, *Secretary*, T T Dawson, M D, Fourth and Pike Bldg, Seattle Meetings fourth Monday of each month at College Club

WISCONSIN

Milwaukee Roentgen Ray Society—*Secretary* S A Morton, M D, Columbia Hospital, Milwaukee Meets monthly on first Friday

Radiological Section of the Wisconsin State Medical Society—*Secretary*, Russel F Wilson, M D, Beloit Municipal Hospital, Beloit Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September

University of Wisconsin Radiological Conference—*Secretary*, E A Pohle, M D, 1300 University Ave, Madison Wis Meets every Thursday from 4 to 5 P M Room 301, Service Memorial Institute

NEWS ITEM

Conference of Eastern Radiologists (Philadelphia Session), sponsored by Philadelphia Roentgen Ray Society, met Jan 28, 29, 1938 Program of 41 papers Experiment was tried of holding all sessions in one central meeting place, and a ballot was to be taken to determine the success or failure of plan

and contributing. The *first annual exhibition* promises to be of unusual interest with entries to be accepted (after jury selection) in the following classifications: oils, water colors, sculpture, photography, pastels, etchings, crayon and pen and ink drawings (including cartoons), wood carvings, and book bindings. Scientific medical art work will not be accepted. The exhibition is not limited to first showings. All entries close April 1, 1938. Any physician interested should communicate at once with the Secretary of the American Physicians' Art Association, Suite 521-536 Flood Bldg., San Francisco, California.

IN MEMORIAM

FRANCIS P. GARVAN

An expression of regret and sympathy over the passing of Francis P. Garvan on November 7, 1937, seems tardy at this date, but the sad fact has only now come to the knowledge of some of us who knew Mr. Garvan as a generous benefactor of chemistry and of the study of disease and not at all as an individual. "The American Journal of Cancer," in its December, 1937, issue, contains a splendid editorial concerning Mr. Garvan's career. That Journal was the recipient of a generous share of his beneficence, as was also *RADIOLOGY* and individual research workers. Mr. Garvan gave freely of the funds at his command for the furtherance of medicine and chemistry.

In a biographical sketch, "Chemical Industries" says: "Being a man of vibrant energy and brilliant ability, he was able to accomplish many important, tangible things for those educational and industrial causes to which he devoted himself. Such service as he gave will be sorely missed, but to the hundreds of chemical people who had felt the firm grip of his hand, who knew the twinkle in his blue eyes, who had come to appreciate the jut of his jaw and the pound of his fist when he was thoroughly aroused, his passing means a more intangible but quite irreparable loss. It was his confidence in the American people, his loyalty to his friends, it was the courage with which he backed his convictions and the doggedness with which he followed his ideals, it was his bright optimism, his Celtic wit, his warm sincerity—these are the gifts he bestowed freely which cannot be replaced."

"The Wall Street Journal," in a lengthy comment on Mr. Garvan's career, said: "His in-

terest in the American chemical industry dated from the War when, as Alien Property Custodian, he took over the seized German chemical patents. These patents, covering many important German processes for manufacturing dyes and pharmaceuticals, were bought from the Government by the Chemical Foundation and leased to American manufacturers on a royalty basis.

"The funds received from this source were used in research, for scholarships, and to promote an American chemical industry. Mr. Garvan was one of the most dynamic and dramatic of characters, with a mind always working along untrodden lines.

"Many of his ideas, at variance with the general thought of the time when he evolved them, since have become a widely accepted part of our national thought. He was an ardent nationalist and worked untiringly to promote his belief that America must be industrially and financially self-contained and free from dependence on European scientists or capital.

"The vital need of the United States for its own scientific research and for its own drug and chemical industries was brought home to him during the War. From the time his young daughter died, due, he believed, to lack of sufficient technical knowledge in the United States and to lack of essential drugs available in Germany, he labored to bring this country to the point of leadership in scientific industry which it since has attained."

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CUTANEOUS CANCER AND PRECANCER. A Practical Monograph. By GEORGE M. MACKEE, M.D., Professor of Clinical Dermatology and Syphilology and Director of Skin and Cancer Unit, New York Postgraduate Medical School and Hospital, Columbia University and ANTHONY C. CIPOLLARO, M.D., Associate in Dermatology, Skin and Cancer Unit, New York Postgraduate Medical School and Hospital, Columbia University. With a Foreword by FRANCIS CARTER WOOD, M.D. A volume of 222 pages, with 245 illustrations. Published by The American Journal of Cancer, New York, 1937. Price \$3.75.

DIATHERMY. Including Diathermotherapy and Other Forms of Medical and Surgical Electrothermic Treat-



Portrait by Lee F. Redman Detroit

HOWARD P DOUB, M D
PRESIDENT OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Anemia	264	Radiation Injuries	269
Arteriography	264	The Spine	269
Arthritis	264	Suprarenals	270
The Blood	264	Syphilis	270
Bone Diseases (Diagnosis)	205	The Thyroid	271
Bone Roentgenography	205	Tuberculosis, Pulmonary	271
Breast Cancer	205	Tumors (Diagnosis)	272
The Cranium	206	Tumors (Therapy)	272
Cysts, Cutaneous	206	Ultra violet Light	274
Gonorrhea	207	Urethra (Cancer of)	275
Gynecology and Obstetrics	207	The Uterus	275
The Lungs	208		

THE FOLLOWING ABTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J N AVE, M D, of New Orleans, La	HANS W HERFAS M D, of Milwaukee, Wis.
S M ATKINS M D, of Waterbury, Conn	L G JACOBS M D of Madison, Wis
S RICHARD BLATT, M D of Madison, Wis	ERNST A POHLE M D Ph D, of Madison Wis.
G C BURCH, M D, of New Orleans, La	W A SODEMAN M D, of New Orleans La
J E HABBE, M D of Milwaukee, Wis	CHARLES G SUTHERLAND, M D, of Rochester Minn

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

AMBUVILLE ROYNEAU, G, HINAULT and DES CREZ H Pulmonary Arteriography in the Living	204	GAUSS C J Has Our Discard of Operative Therapy in Uterine Fibroids and Preclumac- teric Metropathies Proved to be Good Practice?	275
ALLEN, KENNETH D A Roentgen Evidence of the Behavior of the Human Lung in Recent Tuberculous Infections	208	GROSS ROBERT E Recurring Myxomatous Cutaneous Cysts of the Fingers and Toes	266
AUDRY and BERTRAND GUI Pirirenal Insuffla- tion	209	GRÜNEIS, P An Apparently Solitary Myeloma	272
BARNWELL JOHN, with SAMSON PAUL C, jt auth	271	GUTMAN ALEXANDER B with KASABACH HAIG H, jt auth	265
BARTH EARL E Some Roentgen Considera- tions of the Childhood Type of Tuberculosis	272	HELLNER HANS Radiation Tumors	269
BASSE, W with SCHMITT F jt auth	264	HELLWIG FERDINAND C The Relative Impor- tance of Histological Analysis in Tumor Therapy	273
BÉCLÈRE A Radiation Cancer in Radiologists	269	HINAULT with AMBUVILLE jt auth	264
BERING I R Sensitization of the Skin to Ultra violet Light	275	HODGES, PAUL C Roentgen Pelvimetry and Fetometry	268
BERTRAND GUI, with AUDRY, jt auth	269	JÜNGLING O The Chorionepithelioma of the Male	273
BERTRAND GUI, with DUMOLARD jt auth	270	KALZ F Injuries Following Bucky Irradia- tion	269
BUGHIER JOHN C with SAMSON PAUL C jt auth	271	KASABACH, HAIG H and GUTMAN ALEXANDER B Osteoporosis Circumscripta of the Skull and Paget's Disease 15 New Cases and a Review of the Literature	265
CARREY JOHN The Skeletal Changes in the Chronic Hemolytic Anemias (Erythroblastic Anemia Sickle-cell Anemia and Chronic Hemolytic Icterus)	264	KATTENTIDT, BALDER When is Roentgen In- vestigation of the Lungs Necessary?	268
COCHENS K D with KEMP J E jt auth	270	KEMP J E and COCHENS K D Studies in Cardiovascular Syphilis Teleroentgen- ography in Diagnosis of Early Syphilitic Aortitis Comparison of Findings in 1,000 Syphilitic and 600 Non syphilitic Individuals	270
COHN, MAX. Bronchography as an Aid in the Diagnosis of Carcinoma of the Lung	268	KIENBÖCK R Malacia of the Neck of the Fe- mur with Combined Degeneration of Hy- pophysis and Thyroid	271
DAHL B How Does Necrotic Roentgen Ulcer Develop?	269	LANGERON with DESPLATS jt auth	270
DESGREZ H, with AMBUVILLE jt auth	264	LITTEG JOHN with SAMSON, PAUL C jt auth	271
DESPLATS and LANGERON Radiotherapy of Suprarenals in Endarteritis Obliterans	270	LOUP, P Treatment of Gonococcal Arthritis with Radio-active Substances	267
DUMOLARD BERTRAND-GUI TILLIER, and POROT A Case of Calcification of the Ab- dominal Aorta	270	MACCARTY WILLIAM CARPENTER Microscopic Grading of Tumors Its Interpretation Limitations and Relation to Radiosensi- tivity	272
EHRLHARDT K The Drinking Fetus	268		
FARMER HARRY L Accessory Articular Proc- esses in the Lumbar Spine	270		
FREUND, F F Clinic and Therapy of Profes- sional Injuries Due to Roentgen Rays	269		
GAL F Diagnosis and Treatment of Tubercu- losis of the Female Genital Organs	267		

east, it has, however, very definite limitations

The question of biopsy in mammary cancer is so well known that it probably needs no comment here, except to say that some of our leading pathologists agree that even this method at times proves difficult. As eminent a pathologist as Dr. James Ewing (1) is reported in the "Bulletin of the American Society for the Control of Cancer" as stating

"There are some lesions in the breast in which it is difficult for any surgeon or pathologist to state positively whether the condition is malignant or benign. Hence, the surgeon must not assume that by obtaining a microscopic diagnosis he has secured positive information. In such cases the clinical data, age of patient, extent and duration of the disease, condition of lymph nodes, and especially the gross character of the lesion should be given much importance in the decision. Under these circumstances, some surgeons would err on the side of caution and perform the radical operation. I believe it is unfair to the patient to perform a radical mastectomy unless the diagnosis of carcinoma is positive. There are many pre-cancerous and suspicious lesions in the breast which are clinically benign, while a true carcinoma is nearly always obvious to a pathologist of adequate experience. When a substantial doubt exists about the nature of a microscopic section of a breast tumor, it is generally not cancer."

Roentgenographic examination of the breast, popularized by Lockwood (2) and others, has also proven of value and has been the means of demonstrating many conditions affecting the breast such as mastoplasia, cystiphorous desquamative epithelial hyperplasia, fibro adenoma, chronic cystic mastitis, fibrosis of the breast, lymph nodes in the axilla, carcinoma, etc.

Recently Hicken (3) reported certain observations made by a new method of examining

the breast obtained by injecting thorium dioxide (thorotrast) into the ducts of the gland, followed by roentgen examination. This method of diagnosis is termed mammography. In this manner the ducts and their ramifications are clearly outlined. A careful study of the normal virginal breast and the multiparous breast was made and studied in order that the abnormal might be better understood. This method of examination, which is of very recent date, has clearly outlined in certain instances such conditions as papilloma, lipoma, cyst, and carcinoma. The technic is clearly and fully outlined in recent contributions (2 and 3).

There has been a considerable discussion in regard to the danger of the use of thorium dioxide as a diagnostic means in medicine on account of its radio-active principle. This has been in instances wherein it has been injected intravenously when it is readily taken up by the reticulo endothelial system where it remains for a very long period of time. It would seem that the use of thorium dioxide as it is employed in mammography would not be considered dangerous.

In mammography we apparently have a method of examining the breast which will lead, along with the methods already mentioned, to an early diagnosis of disease conditions.

We all appreciate that rapid advancement is being made in the diagnosis of the pre-cancerous state and of early cancer of the breast, which indicates the great interest constantly being manifested in regard to the control of cancer of this organ.

BIBLIOGRAPHY

(1) EWING JAMES Bull Am Soc Control of Cancer January 1933

(2) LOCKWOOD IRA H, and STEWART WENDELL. Roentgen Study of Physiologic and Pathologic Changes in Mammary Gland Jour Am Med Assn, Oct 29 1932 99, 1461

(3) HICKEN N F Mammography The Roentgenographic Diagnosis of Breast Tumors by Means of Contrast Media Surg Gynec and Obst March, 1937 64, 593

ANNOUNCEMENT

AMERICAN PHYSICIANS ART ASSOCIATION

The American Physicians Art Association, a national organization of medical men who have ability in the fine arts will hold a *first national*

exhibition in the San Francisco Museum of Art, San Francisco, in June, 1938. (The American Medical Association Session will be held June 13-17 in the same city.) The American Physicians Art Association already has an outstanding membership. There are three classifications for membership: active, associate,

ANEMIA

The Skeletal Changes in the Chronic Hemolytic Anemias (Erythroblastic Anemia, Sick-cell Anemia and Chronic Hemolytic Icterus) John Caffey *Am Jour Roentgenol and Rad Ther*, March, 1937, 37, 293-324

In these diseases the bone marrow in attempting an over-production of erythrocytes, becomes hyperplastic and expands, resulting in secondary bone changes. The earliest changes noted have been thickening of the lower portion of the frontal squamosa and horizontal plate, as well as the distal ends of the femora. The heart hypertrophies early, later osteoporosis and heavy trabeculations appear. The vertical striations of the skull and atrophy of the outer table are not as constant as the long bone changes, especially in the metacarpals, which show the expanded marrow thin cortex and rectangular outline. Later in the disease the vertical striations disappear to be replaced by osteosclerosis. Mild cases show no definite changes.

The clinical signs antedate by several months the roentgen findings. The heart hypertrophies early. Malnutrition and under development are present in all cases of early life.

In sickle cell anemia the splenomegaly and cardiac hypertrophy are less frequent. Only two-thirds showed thickening, which was limited mainly to the parietal bones. Striations were absent.

Chronic hemolytic icterus shows no definite changes in long bones and but rarely in the skull.

S M ATKINS, M D

ARTERIOGRAPHY

Pulmonary Arteriography in the Living. Anieulle G. Ronneaux, Hinault, and H. Desgrez. *Bull et Mém Soc Radiol Med de France* February 1937 25, 119-122

By introducing an urethral catheter 60 cm. long size 11 or 12, into either the left cephalic or basilic veins it is possible to approach the opening of the vena cava superior into the right auricle. Rapidly injecting 8 to 10 cc. of 120 to 140 per cent sodium iodide and taking roentgenograms immediately, one secures well outlined shadows of the pulmonary arteries. The technic must be meticulous and often it is not possible to introduce the catheter to the proper level. Immediately following the injection there is often transient headache with occasionally, slight fever or evidence of mild iodism. Otherwise no sequelæ have been noted (75 cases). A second injection (20 grams iodine total) may be given after six minutes if other views are necessary. Tuberculosis is not *per se* a contra indication.

The angio-pneumograph permits estimation of the distribution and caliber of the (larger) pulmonary arteries throughout their extent.

Parts involved by tuberculosis or abscess show diminution of or loss of vascularity.

Bronchiectasis causes marked change in the distribu-

tion of blood vessels. The procedure is frequently unsuccessful in cases of bronchiectasis.

S RICHARD BEATTY, M D

ARTHRITIS

So called Arthritis Mutilans. J. Schüller. *München. med. Wchnschr.* Aug 27, 1937, 84, 1381

The author describes six cases of arthritis mutilans, so named by Stursberg, in 1935. The multiplicity of etiologic agents, the lack of uniformity of the microscopic changes, and the lack of microscopic evidence of inflammation in the joints lead him to conclude that this is not a true arthritis and that the name is a poor one. (Apparently from his cases, the condition is the one commonly known as neurotrophic osteo-arthritis here, as two of the cases had spina bifida and two myelodysplasia.)

L G JACOBS, M D

THE BLOOD

The Effect of Visible and Infra red Light Emitted by a New Lamp on the Blood Picture of Man. R. Möhring and E. Witte. *Strahlentherapie*, 1937 60, 142

The authors describe first a new lamp which was used in their experiments and the spectrum of which is very similar to that of the sun. The infra red rays above 1200 mμ were filtered out by a water filter. The blood of 50 persons exposed to the rays was studied before and after the treatments. The number of erythrocytes and the percentage of hemoglobin were found increased and the authors conclude, therefore, that undoubtedly a beneficial effect on the blood can be obtained by irradiation from artificial sources of light.

ERNST A. POHLE, M D, Ph D

The Effect of Therapeutic Doses of Roentgen Rays on the Electrolyte Content of Plasma and Erythrocytes in Cases of Basedow's Disease, Leukemia and Lung Tumor. F. Schmitt and W. Basse. *Strahlentherapie* 1937 59, 119

The authors studied the blood chemistry in six patients with Basedow's disease, six cases with leukemia and ten cases with lung tumors. The latter included carcinoma, sarcoma and Hodgkin's disease. In Basedow's disease the potassium and calcium content of the plasma was increased. The chlorine, sodium, and calcium content of the erythrocytes was decreased before irradiation. After irradiation the plasma showed normal values while chlorine and sodium increased in the erythrocytes and calcium almost disappeared. Potassium and calcium were found increased in the plasma of leukemic patients the same as were the chlorine and potassium content of the erythrocytes while sodium and calcium values were lower than normal. Following irradiation chlorine and calcium values were higher in the erythrocytes, the potassium content smaller, with an increase of potassium in the plasma. In patients with malignant lung tumors large doses of roentgen

ment By ELKIN P CUMBERBATCH, M A, B M (Oxon) D M R E (Camb), F R C P, Medical Officer in Charge of Electrical Department and Lecturer on Medical Electricity, St Bartholomew's Hospital With nine collaborators Third Edition A volume of 576 pages with 168 illustrations Published by William Wood & Company, Baltimore, 1937 Price \$6 00

FRACTURES AND DISLOCATIONS FOR PRACTITIONERS By EDWIN O GECKLER, M D, Fellow of the American College of Surgeons, Fellow of the American Academy of Orthopedic Surgeons A volume of 252 pages, with 213 illustrations Published by William Wood & Company Baltimore, 1937 Price \$4 00

BOOK REVIEWS

ROENTGENATLAS FRUEHTUBERKULOESER VER-
AENDERUNGEN IM HILUS BEI SYSTEMATI-
SCHEN STANDARDQUERAUFNAHMEN By DR
R CZARNECKI, Leiter der Tuberkulose-
Abteilung im Staatl Gesundheitsamt Leip-
zig-Land Fortschritte auf dem Gebiete der
Röntgenstrahlen, Ergaenzungsband 51 A
volume of 98 pages, with 308 illustrations
and one plate Published by Georg Thieme,
Leipzig, 1936 Price 21 60 M

The author presents a comprehensive report supported by 308 illustrations based upon his systematic observations of disease of the hilus over a period of eight years The illustrations were chosen from thousands of cases which had been studied by paired postero-anterior and right lateral films of the chest, taken at periodic intervals or in rapid sequence, as the clinical progress demanded, or as research interest indicated

The purpose of the atlas is to demonstrate that by means of periodic lateral films made under the same conditions involvement and healing of disease of the hilum, with or without involvement of the lung, may be observed and evaluated The author not only stresses the roentgenologic and technical factors, but also enlarges upon his concept of the biologic dynamic in the progress of tuberculous infection

The article should be studied in detail in order to become familiar with the subject matter The technical factors of position are stressed, especially that covering the right lateral study The identification of the anatomical structures concerned with the hilum and with the distribution of the bronchial trunks into the lung-fields is well covered This is followed by detailed discussion of the manner of participation of the hilum lymphatic structures in the various stages of tuberculosis,

with emphasis placed on their importance in the primary and secondary stages, in the persistence of tuberculous activity in the glands over many years, and in their rôle as the source of endogenous spread of the disease and of hematogenous dissemination Several pages are devoted to a discussion of the various phases of the three stages of tuberculosis, and their interrelation In addition to the usual other methods of treatment, the author has had very satisfactory results with roentgen irradiation over the mediastinum Small doses are given over one anterior and one posterior field, at intervals of from three to eight or more days, never while there is still a systemic reaction Irradiation is contra-indicated in the presence of active secondary or tertiary lung lesions, since it would interfere with the lymphatic circulation between the active lesion and the regional nodes

The diagrams and paired illustrations of the author's selected cases are excellently reproduced, and constitute a comprehensive demonstration of the value of these roentgenologic procedures

DER TUBERKULOSE PRIMÄRKOMPLEX IM RÖNT-
GENBILDE EINE KRITISCHE STUDIE (The
Primary Tuberculous Complex in the Roent-
genogram A Critical Study) By DR J F
SLOOFF Number 63, Tuberkulose Biblio-
thek A volume of 80 pages, with 61 illus-
trations Published by Johann Ambrosius
Barth, Leipzig, 1937 Price 8 M

In his monograph, "The Primary Tuberculous Complex in the Roentgenogram," Dr Slooff presents a work valuable to the student of chest diseases It consists of an introduction, a brief summary and review of the related literature (this is considered from two angles, first, the anatomical, and, second, the roentgenologic), the author's investigations, discussion, observations, summary, and bibliography The section on the author's own investigations is wisely subdivided into (a), discussion of method and technique, and (b), detailed case reports of 20 patients of both sexes ranging in age from seven months to twenty-two years

The work is well illustrated with roentgenograms, descriptive pen sketches, and post-mortem photographs of the lungs The whole monograph is well done, with close attention given to important detail and a nice sense of discrimination in choice of material

to radical surgery and the five year 'cure' rate of this period was 30 per cent. Since 1924 pre operative and post operative therapy have been added to radium and radical surgery and the five year 'cure' rate has been increased to 55 per cent. Of interest also is the fact that only one local recurrence has been noted in 117 patients irradiated before surgery while the non irradiated group previously had local recurrences in slightly over 5 per cent.

J. N. ANÉ, M.D.

THE CRANIUM

The Reliability of the Roentgenographic Signs of Intracranial Tumor. Merrill C. Sosman. *Am Jour Roentgenol and Rad Ther*. December 1936 36, 737-743.

Sosman states that 'one's relative value in assisting the often long and involved course leading to a correct diagnosis is in inverse ratio to the clinical experience and judgment of the physician referring the patient' (a statement relating, particularly to the author's chosen subject but equally applicable to any major diagnostic problem).

The writer's comments are based upon the x ray findings of all cases referred for skull study from both the neurosurgical and medical services for a period of one year. Positive findings were grouped as showing (1) non specific signs of intracranial tumor (2) localizing signs and (3) characteristic signs permitting identification of the type of tumor.

An interesting observation obtained from analysis of the cases examined from the medical service of the hospital is that one may expect to find about one brain tumor case per 100 medical admissions since 26 cases with 18 subsequently verified by the neurosurgical service were found in 1900 hospital admissions. Further analysis of the material supplied by the medical service revealed slightly greater accuracy of the x ray examination (without encephalography and ventriculography) than by clinical examination by a group of medical men not particularly brain tumor-conscious. To his considerable surprise the writer found that in the present series by plain radiographic studies he was able to predict the location of the tumor in about one half of the cases and to guess its histologic type in one fourth of the group. Concerning percentage accuracy in localization in the verified group it was found that with pituitary adenomas the accuracy was 91 per cent meningiomas 67 per cent acoustic neuromas (confirmed by x ray) 53 per cent cerebellar tumors (compatible not diagnostic) 45 per cent gliomas 28 per cent.

The most valuable view for the study of the acoustic neuroma is the direct anteroposterior view showing the petrous ridges in the center of the orbits.

The position of the silver clips used for hemostasis is important to note in re-examining for recurrence or for the results of roentgen therapy.

If ventriculography is resorted to practically all in-

tracranial tumors of sufficient size to produce symptoms should be correctly treated.

J. E. HABBE, M.D.

CYSTS, CUTANEOUS

Recurring Myxomatous, Cutaneous Cysts of the Fingers and Toes. Robert E. Gross. *Surg Gynec and Obst*, September, 1937 65, 289-302.

The author discusses the results of his study of myxomatous, cutaneous cysts of the fingers and toes reviews 14 cases of this condition reported in the literature, and presents eight additional examples. This rather rare lesion was described by Jones and Markins and later by Hyde.

In the author's series the cysts varied from 5 to 12 millimeters in diameter and consisted of smoothly rounded thin walled structures of the color of normal skin or with a faint yellowish or bluish cast. Tenderness is mild or absent. The cyst is found only on the dorsal surface of the digit usually in the proximity of a joint.

Pathologically the cysts show a degeneration or resorption of the collagen in a localized area of the derma. The fibroblasts remain in a framework with but little intracellular material. Between the separated cells there then collects a faintly staining basophilic mucoid material which increases in amount. The fibroblasts then disappear and minute cavities appear. The increase in number and size of the cavities results in a grossly visible cyst containing a clear and glairy fluid of gelatinous consistency. No communication with a subjacent structure such as a joint cavity tendon sheath or bursa has been noted. The mucoid material is therefore, the result of degeneration of local connective tissue.

While the pathogenesis of cutaneous cysts is unknown two theories are presented. The first theory is based on degenerative processes set up by local trauma. The second explanation is that the cysts result from localized alteration of blood supply. While these have been called synovial lesions the basis is without foundation for there is no connection with any of the synovial membranes. The idea of neoplasia can also be eliminated for the pathological findings are those of a degenerative and not a neoplastic lesion.

The treatment of choice in cutaneous cysts is radiation therapy. All types of surgical therapy such as drainage excision curettage and insertion of sclerosing fluids are of no avail. The author employed x ray therapy in six cases using in each 600 r given in two doses of 300 r each two days apart. In five lesions there was no recurrence but in one case an additional 900 r was given. Sutton used 10 mg of unscreened radium and a dosage of 40 milligram hours in one patient. In the author's opinion an intense local reaction must be produced in order for the treatment to be effective.

J. N. ANÉ, M.D.

- DU MESNIL DE ROCHEMONT R Radiation Therapy of Malignant Tumors 273
- MIESCHER, G Are Exposures to Ultra violet and Sun Radiation Dangerous? 274
- MÖHRING R, and WITTE, E The Effect of Visible and Infra red Light Emitted by a New Lamp on the Blood Picture of Man 264
- MOREAU, L Remarks on Certain Profile Radiographs of Bone 265
- NAGELL H, and NOETHLING, W Experimental Studies Regarding the Possibilities of the Use of Alpha Rays in the Treatment of Gonorrhea 267
- NIEFF, TH C The Time Factor and Tolerance Doses with the Protracted Dose Method in Gynecology 267
- NOETHLING W *with* NAGELL H, jt auth 267
- NOGIER, M T Enormous Tumor of the Breast Treated and Cured by X rays Filtered through Three Millimeters Aluminum Only 274
- OTT P Roentgen Therapy of Superficial Tumors 274
- PAGANI, A Radiotherapeutic Experiences in Malignant Tumors of the Upper Respiratory and Digestive Tracts with Regional Lymph Node Involvement 272
- PARSONS, W H, *with* SPARKS T P JR, jt auth 275
- PETITFRÈRE *with* ROCMANS M jt auth 273
- PICKHAN, A Some Considerations in the Treatment of Carcinoma of the Cervix by Ir radiation 275
- POROT *with* DUMOLARD jt auth 270
- POTTER, B P The Problem of Tuberculosis 271
- RAAGAARD O Roentgen Treatment of Exophthalmic Goiter 271
- REICHENMILLER, H The Value of a Supine Lateral Roentgenogram as an Obstetrical Guide 267
- RICHARD M Traumatic Localization of a Tumor Metastasis (?) 272
- ROCMANS M and PETITFRÈRE Endometrioma 273
- RONNEAUX, G *with* AMEUILLE jt auth 264
- RUSBY, N LLOYD The Differential Diagnosis of Mediastinal Tumors 272
- SAMSON, PAUL C, BARNWELL JOHN LITTIG JOHN and BUGHER, JOHN C Tuberculous Tracheobronchitis 271
- SCHIEDEMANDEL F The Sedimentation Test in Tuberculosis and Syphilis 270
- SCHINZ, H R The Experience in Zürich with the Irradiation of Malignant Tumors of the Glandular Organs in the Abdomen Excluding Gonads (1919-1935) 274
- SCHMITT F, and BASSE W The Effect of Therapeutic Doses of Roentgen Rays on the Electrolyte Content of Plasma and Erythrocytes in Cases of Basedow's Disease, Leukemia and Lung Tumor 264
- SCHREUS H TH Indications for the Treatment of Malignant Tumors of Skin, Mouth and Larynx 274
- SCHRÖDER, R Therapy of Cancer of Uterine Cervix at Gynecologic Clinic in Kiel from Oct 1, 1922 to Dec 31 1930 275
- SCHÜLLER J So-called Arthritis Mutilans 264
- SOSMAN, MERRILL C The Reliability of the Roentgenographic Signs of Intracranial Tumor 266
- SPARKS T P JR, and PARSONS W H Carcinoma of the Female Urethra Case Report with Summary and Review of the Literature 275
- TILLIER, *with* DUMOLARD jt auth 270
- TROUT HUGH H Carcinoma of the Breast 265
- VAN EVERDINGEN W A G Application of Ultra short Waves, with Special Regard to Malignant Tumors 274
- WITTE E, *with* MÖHRING R jt auth 264

patients had tuberculosis of the tubes. Twenty two of the irradiated women were treated with roentgen rays alone, one with radium exclusively, and three were treated with the combined method. As a rule small doses were given, most patients received one third of the sterilization dose for four or five sittings at intervals of from four to five weeks. The appearance of the menopause is usually followed by an improvement in the condition of the patient, amenorrhea is therefore, considered beneficial in the treatment of these cases. All irradiated women had some form of surgery, so that the diagnosis had been verified histologically in each instance. The results of radiation therapy were encouraging, in localized processes the end results following operation and irradiation were about the same. The author states, however, that in early cases with limited involvement removal of the adnexa or vaginal hysterectomy is the method of choice because of assured results. Tuberculosis limited to the cervix can be treated successfully by radium without danger. The same holds true of tuberculosis of the uterus if there are contra indications to surgery.

ERNEST A. POHLE M.D. Ph.D.

The Drinking Fetus. K. Lhrhardt. München med Wehnschr. Oct 22, 1937, 84, 1699-1700.

In a 21-year old woman, pregnant six months, eugenic sterilization and abortion was done. Before the operation the author replaced 8 cc of amniotic fluid with colloidal thorium dioxide. The operatively removed specimen consisted of the fetus and membranes intact. Roentgenograms of this of the fetus alone, and of the fetal gut all showed thorium dioxide in the gut. The author concludes that the fetus normally swallows significant quantities of amniotic fluid. He briefly mentions some of the possible applications of this fact.

L. G. JACOBS M.D.

Roentgen Pelvimetry and Fetometry. Paul C. Hodges. Am Jour Roentgenol and Rad Ther. May, 1937, 37, 644-662.

A review of the recent publications in this field and the author's own work lead to the fact that no single method has been accepted as standard and opinion varies on what information should be sought. There is a growing recognition of the importance of a qualitative survey of the pelvis as a whole that is whether of the gynecoid android anthropoid or flat type the subpubic angle and other factors enumerated by Caldwell and Moloy rather than the diameters alone.

Of the three methods now employed (1) the position (2) stereoscopic (3) the one introduced by Ball and Marchbanks the multiple stereoscopic views method is the one of choice but owing to the simplicity and inexpensiveness of the Ball and Marchbanks' method which the author suggests calling 90° triangulation he believes the latter will be increasingly employed. To overcome the objections of possible movement of the skull during the examination the author has devised a jacket in which the patient is strapped and for Ball and

Marchbanks' method of correction of triangular distortion, he has substituted equations and graphs based on definite sound mathematics.

S. M. ATKINS M.D.

THE LUNGS

Bronchography as an Aid in the Diagnosis of Carcinoma of the Lung. Max Cohn. Le Cancer 1935, 12, 251-258.

In most cases carcinoma of the lung originates in the bronchi, and the radiologic diagnosis depends on indirect evidence, due primarily to complete or partial occlusion of the bronchus, atelectasis or retention of secretion. Consequently, the radiologic study is frequently negative especially in the early stages of the disease or if the tumor is in one of the smaller bronchi.

The technique of bronchoscopy as developed in America permits not only direct visualization but also the directed filling of the bronchi with iodized oil. This is accomplished without distress to the patient by preliminary anesthesia of the lower respiratory tract.

Bronchography with the aid of opaque oil has made possible visualization of the suspected area from all directions and aided in determining the site of occlusion not visible on plain roentgenograms in the upper as well as the lower lobes. The lateral and oblique views are indispensable.

S. RICHARD BEATTY M.D.

Roentgen Evidence of the Behavior of the Human Lung in Recent Tuberculous Infections. Kenneth D. A. Allen. Am Jour Roentgenol and Rad Ther. May 1937, 37, 603-612.

Both animal experimentation and serial roentgen examination of human patients show that first infection tuberculosis of lung parenchyma is quickly carried away to the hilum, but that subsequent infections remain where the infection occurs. In the serial examinations the original parenchymal involvement was seen to subside rapidly during which time the hilum became enlarged and hilar glands appeared to be in turn followed by only a Ghon tubercle in the parenchyma and calcification in the hilum as a monument to this first infection. A subsequent parenchymal infection remains in the parenchyma without drainage to the hilum.

S. M. ATKINS M.D.

When is Roentgen Investigation of the Lungs Necessary? Balder Kattentidt. München med Wehnschr. Oct 15 1937, 84, 1647-1652.

The author concludes from certain statistics that he found rather fewer patients with tuberculosis among those presenting symptoms than among those symptom free and that a roentgenogram of the chest is essential to the early diagnosis of lung tuberculosis even in the face of a negative history. The article contains some discussion of the stand of the German National Tuberculosis Committee and the *Krankenkassen* on the subject.

L. G. JACOBS M.D.

rays reduced the chlorine in the erythrocytes while the calcium increased. In the spinal fluid of one patient with a tumor of the hilus only one sixth of the normally present chlorine was found, while calcium was increased 400 per cent.

ERNST A. POHLE, M.D., Ph.D.

BONE DISEASES (DIAGNOSIS)

Osteoporosis Circumscripta of the Skull and Paget's Disease. 15 New Cases and a Review of the Literature. Haig H. Kasabach and Alexander B. Gutman. *Am Jour Roentgenol and Rad Ther*, May 1937, 37, 577-603.

The disease begins as small rounded circumscribed areas of osteoporosis often in the frontal region near the base, sometimes in the occipital region, occasionally elsewhere. These usually expand to involve almost the entire calvarium. This condition as proven by the literature and the cases of the authors from a follow-up of some years, is a precursor of Paget's disease, though Paget's may occur without this precursor. If Paget's disease is not already present, it will appear later though years may elapse.

Symptoms are usually absent though headache, vertigo, migraine and epileptiform attacks may occur. Age incidence is that of Paget's though the peak age occurs two decades earlier. Occasionally this condition is associated with a bony tumor of the maxillary

S. M. ATKINS, M.D.

BONES, ROENTGENOGRAPHY

Remarks on Certain Profile Radiographs of Bone. L. Moreau. *Bull et Mem Soc de Radiol Méd de France*, January, 1927, 25, 49, 50.

The usual position for obtaining profile views of the shoulder joint with the arm in full abduction with the film above and the ray entering through the axilla is often difficult and painful, if not impossible to obtain. Except rarely, the anterior views are sufficient. To obtain profile views of the head and neck of the humerus it suffices to take views with the arm rotated externally. Profile views of the superior epiphysis of the humerus are obtained when the arm is abducted to right angles with the hand behind the head.

The usual techniques for obtaining profile views of the neck of the femur require positions much too complicated. In the usual position with slight external rotation one obtains a frontal view. To obtain an inside view and define the neck, rotate the leg inward. A profile view of the neck is obtained with the thigh in flexion and abduction. If these views are impossible, stereoroentgenography will suffice.

To obtain conveniently and without distress to the patient, vertical views of the calcaneus, the patient rests prone with the foot at right angles to the leg and the toes on the table. The cassette is against the sole and the central ray is directed obliquely through the heel.

S. RICHARD BRATT, M.D.

BREAST CANCER

Carcinoma of the Breast. Hugh H. Trout. *Surg, Gynec and Obst*, September, 1937, 65, 370-375.

The author reviewed the histories of 518 cases of carcinoma of the breast which were seen over a period of 25 years. Some form of dysfunction of the breast was noted in 88 per cent of these histories before carcinoma was found.

The author discusses various theories concerning possible etiological factors in the development of breast carcinoma. Lack of function of the breasts and early interruption of lactation, with failure to remove the products of lactation which may prove irritating, are mentioned as possible factors. He is of the opinion, also, that carcinoma could be 'bred out' were it possible to mate human beings biologically as Maud Slye has done with mice.

In the diagnosis of breast carcinoma an attempt is made to obtain a classification of the lesion according to the histological method of grading and also to the clinical index of malignancy as advocated by Lee and Stubenbord. The clinical method of grading is believed to be superior to the histological classification. Routine x-ray examination of the chest, pelvis and long bones should be made in all cases. In 100 cases of breast carcinoma, the author found five patients with metastases, two of which showed no indication of such lesions before the x-ray examination.

Pre-operative radiation is considered of more value than post-operative therapy. Such improvement is noted in from four to six weeks in many of these cases that the danger exists that some of the patients may fail to return for surgery. A complete Halsted type of operation is performed in every case if possible. A small stab incision is made in the mid axillary line and 50 mg of radium and a light rubber drain are placed in the opening. The drain is placed between the axillary vessels and the radium. An additional 50 mg of radium is placed in the area supplied by the internal mammary vessels and lymphatics. Four 12.5 mg radium needles are equally distributed in a rubber tube from 12 to 15 inches long. The tube is placed under the skin and the long end brought out through the lower end of the incision. The author states: 'We have never been able to detect how the radium in any way seems to interfere with the healing of the incision or the taking and development of the skin grafts.' Post-operative radiation has been found to produce bronzing of the skin especially in the area previously irradiated by radium. The author believes that an artificial menopause by irradiation of the ovaries should be done in every case in which the patient is still menstruating. Metastases also are irradiated because of the increase in comfort obtained by the patient.

The statistics presented prove the value of radiation therapy and radical surgery in the treatment of carcinoma of the breast. Up to 1920 radical surgery alone was employed and the five year cures were 22 per cent. From 1920 to 1924 radium was added

ing the needle 45 degrees toward the midline aiming at the vertebral body and feeling the way until the needle enters soft tissue that offers no resistance. From 300 to 400 c.c. of air is introduced with a pneumothorax apparatus. The method is no more difficult than lumbar puncture.

S. RICHARD BEATTY, M.D.

Accessory Articular Processes in the Lumbar Spine. Harry L. Farmer. *Am. Jour. Roentgenol. and Rad. Ther.* December 1936 36, 763-767.

In a series of 2535 x-ray examinations of the lower spine 40 cases, or approximately 1.5 per cent, showed accessory articular processes. In the 40 cases there were 60 such anomalies in all, a number of cases showing bilateral involvement or involvement of several vertebra. Most commonly the second and third lumbar segments were affected although some cases were found involving the first, fourth and fifth segments. The vast majority were of the inferior articular facets although there were five instances of superior articular process anomaly.

J. L. HAUNE, M.D.

A Case of Calcification of the Abdominal Aorta. Dumolard, Bertrand, Guy, Tilhier and Porot. *Bull. et Mem. Soc. Radiol. Med. de France* February 1937, 25, 136-137.

In a woman 50 years of age marked calcification of the abdominal aorta in conjunction with an advanced hypertrophic arthritis of the spine with decalcification of the lumbar bodies was demonstrated radiographically. The authors speculate as to the rôle of the parathyroid in such disturbances of calcium metabolism.

S. RICHARD BEATTY, M.D.

SUPRARENALS

Radiotherapy of Suprarenals in Endarteritis Obliterans. Desplats and Langeron. *Jour. d. Radiol. et d'Électrol.*, April 1937 21, 152-153. (Reprinted by permission from *British Med. Jour.* June 26, 1937 page 103 of *Epitome of Current Medical Literature*.)

The authors have treated the adrenals with x-rays in 200 cases of obliterating endarteritis, and claim good results in 62.5 per cent and improvement in 22.5 per cent, only 5 per cent failed to respond to the treatment. Diabetic endarteritis seemed to respond to the treatment in almost every case. They used 130 kilovolts filtered through 5 to 7 mm. of aluminum, 150 to 250 units to each adrenal region alternately every second day until improvement set in. They find that it may be necessary to continue the treatment for one, two or even three months with short breaks between each series of six treatments. In a few cases of intermittent claudication treated in this way the cure has been maintained for seven or eight years.

SYPHILIS

The Sedimentation Test in Tuberculosis and Syphilis. I. Scheidegg. *Deutsches Tuberk. Bl.* March 1937, 11, 69-72. (Reprinted by permission from *British Med. Jour.*, May 1 1937 page 72 of *Epitome of Current Medical Literature*.)

The author has found in an institution serving as a clearing station for definite and doubtful cases of tuberculosis that the rate of sedimentation of the erythrocytes is a valuable guide to differential diagnosis, although this test is not specific but is merely indicative of inflammatory and destructive changes in the body. He gives details of four cases common to which were little or no radiological evidence of active pulmonary tuberculosis, doubtful clinical signs of it, a negative intracutaneous tuberculin reaction, a positive Wassermann reaction and a remarkably high rate of sedimentation. The contrast between this high rate and the negative findings on radiological and physical examination of the chest was striking.

This experience has taught the author to require a Wassermann test whenever the findings of the sedimentation test could not be accounted for by reference to pulmonary tuberculosis, and in the course of the last two years he has by taking this precaution, been able to provide anti-syphilitic treatment for 17 patients the nature of whose disease had not previously been recognized. A rapid rate of sedimentation may well be due to untreated secondary syphilis, whereas in tertiary syphilis this rate is comparatively slow. Indeed it is almost normal in latent forms of syphilis in which the Wassermann reaction is negative. When it is positive, but the syphilis is latent, the sedimentation rate is only slightly raised. When a tuberculous process is slight and scarred and is not calculated to have any effect on the rate of sedimentation, a high rate should raise suspicions of Wassermann positive syphilis running a more or less latent course.

Studies in Cardiovascular Syphilis. Teleröntgenography in Diagnosis of Early Syphilitic Aortitis. Comparison of Findings in 1,000 Syphilitic and 600 Non-syphilitic Individuals. J. E. Kemp and K. D. Cochems. *Am. Heart Jour.*, March 1937 13, 297-307. (Reprinted by permission from *British Med. Jour.* June 26 1937 page 103 of *Epitome of Current Medical Literature*.)

The authors in an attempt to evaluate teleradiographic measurements in uncomplicated early syphilitic aortitis have compared the teleradiographs of the heart and aorta in 1,000 cases of unselected syphilitics with those of 600 unselected non-syphilitic individuals of the same occupational sex and age groups. The Vaquez-Bordet measurements of the supracardiac shadow were used in comparing the width of the aortic arch. Only 59 per cent of patients with clinically recognizable syphilitic aortitis showed teleradiographic evidence of aortic dilatation but there was no evidence that the diagnosis of uncomplicated syphilitic aortitis can be made by teleradiography alone.

GONORRHEA

Experimental Studies Regarding the Possibilities of the Use of Alpha Rays in the Treatment of Gonorrhea H Nagell and W Noetling *Strahlentherapie*, 1937, 59, 419

The authors studied the bactericidal effect of alpha rays on gonococci *in vitro*. If the surface of cultures was exposed to alpha rays, it required from 4 to 60 alpha particles per μ^2 to kill about 95 per cent of the cocci. In a liquid medium it required the energy of from 0.01 to 0.4 alpha particles per μ^2 of liquid medium to produce the same effect. Similar experiments were conducted with thorium X solutions and also with polonium.

The authors conclude that ointments containing about 0.02 to 0.2 mc per cc of radium emanation should be of practical use if applied for several hours per day.

ERNST A POHLE, M.D., Ph.D.

Treatment of Gonococcal Arthritis with Radioactive Substances P Loup *Jour d'Urol*, March 1937, 43, 238-240 (Reprinted by permission from *British Med Jour*, July 10, 1937, p. 6 of *Epitome of Current Medical Literature*.)

The author refers to the serious complications reported by Dr Marsan, which have followed the introduction of radio active substances particularly when intravenous injections of thorium X have been given in cases of gonococcal arthritis. Anemia has sometimes resulted, and in one instance a patient developed an osteosarcoma of the right femur from which he died, several years after intravenous injections of thorium-X had been given. Two personal cases are reported in which this treatment was successful and without complications up to the present. In the first a young man 19 years of age was suffering from a severe attack of gonorrhea which was affecting the joints of the hand. A subcutaneous injection of anti gonococcal serum was given with success. The patient attended only irregularly and returned after several days with severe arthritis of the right knee, which was swollen, painful, and useless. Further injections were given and local treatment applied but the condition of the knee became steadily worse. Intravenous injections of a solution of thorium X were given and the knee which had been ankylosed before the injections began soon could be flexed to a right angle, and after three months movement was completely normal. Seven years later the patient was in perfect health with no disability of the knee joint. In the second instance a woman 28 years of age, had been receiving an intravenous injection of gonococci every other day but in spite of this a typical arthritis developed in the wrist with a synovitis of the right thumb. Anti gonococcal serum was given daily without any effect on the arthritis and so injections of the same solution of thorium X were tried, with the same good result as in the former case. After three years the patient was still in good health. The danger of this form of treatment as emphasized by Dr Marsan is a strong deterrent to its universal use.

GYNECOLOGY AND OBSTETRICS

The Value of a Supine Lateral Roentgenogram as an Obstetrical Guide H Reichenmiller *München med Wchnschr*, Aug 6, 1937, 84, 1254

The author takes a lateral view of the pelvis with the patient supine, and on it measures the conjugata vera. He corrects for distortion by measuring the focus film distance (h'), and the distance to the mid point of the patient at the level of the trochanters (h), which is equal to h' —half the intertrochanteric width. Then the measured conjugata vera, A' , is corrected to the true conjugata vera, A , by the equation $A = \frac{h}{h'} \cdot A'$.

A table showing the comparison with clinical and anatomical measurements is given. The dose of radiation under the conditions he uses is from 9 to 12 r per plate.

Deformities of the pelvis cause difficulty in securing satisfactory measurements, but not more than they do clinically. For satisfactory measurement, plates must clearly show the back of the symphysis, the femur, and the sacrum. The femora and acetabula should be concentrically projected, and centered on the Bucky (which is a rotary grid in his clinic).

Information on the position, height, and configuration of the fetal head is also made available at the same time. The indications for the examination, mentioned at some length are very broad, since no harm can possibly result from it. In certain circumstances it may replace vaginal examination.

L. G. JACOBS, M.D.

The Time Factor and Tolerance Doses with the Protracted Dose Method in Gynecology Th C Neeff *Strahlentherapie*, 1937, 60, 152

Many years of clinical observation and careful physical measurements have led to the development of the following technic in treating cancer of the uterus by roentgen rays and radium in the Women's Clinic of the University of Wurzburg, 14 abdominal and 10 sacral fields are used one field per day. The surface dose is 300 r given in 60 minutes over an area of 400 cm^2 . The total dose over the abdomen is 4,500 r and the one in the depth is 3,400 r. To these roentgen doses a maximum of intra uterine radium of 5,000 mg. hr. is added requiring approximately 27 days for the entire series of treatments. The radium tolerance dose at 1 cm distance for the rectum is 6,200 r, for the bladder 6,600 r, for the vagina 15,400 r. In conclusion the author emphasizes again the necessity of accurate dosage.

I. ERNST A. POHLE, M.D., Ph.D.

Diagnosis and Treatment of Tuberculosis of the Female Genital Organs F Gal *Strahlentherapie* 1937, 59, 513

The author reports his experience in the treatment of tuberculosis of the female genital organs with roentgen rays in a series of 23 cases out of a total number of 70 and compares the results obtained by radiation with those following operation. The majority (42) of the

patients in whom a bronchoscopic diagnosis of tracheo bronchial disease was made, nearly one half showed no evidence of active laryngeal tuberculosis

Roentgenographic evidences include (1) The appearance of intermittent areas of atelectasis in serial roentgenograms of the chest (2) Sudden lobar collapse following a paralysis of the hemidiaphragm or the induction of pneumothorax (3) The visualization of tracheal or bronchial narrowing, particularly in studies made with the Potter-Bucky diaphragm (4) The occasional demonstration of bronchial stenosis beyond the limits of bronchoscopic vision by brominal bronchograms This method of examination has occasionally been useful when the bronchoscopic examination was negative in the face of strong presumptive clinical evidence of tuberculous tracheobronchitis They used bronchoscopy to confirm the suspected presence of tuberculous tracheobronchitis Four types of lesions are recognizable the findings are described in detail Roentgen therapy was used on a series of cases, a critical evaluation of results was not yet justified

CHARLES G. SUTHERLAND M D

Some Roentgen Considerations of the Childhood Type of Tuberculosis Earl E Barth Illinois Med Jour October, 1937, 72, 323-330

Barth concludes that (1) The proper interpretation of a roentgenogram of the chest of a child having tuberculosis requires a knowledge of the pathology as well as of the anatomy and physiology of the lung, (2) a roentgen study of the chest is indispensable in the examination of a child suspected of having tuberculosis, (3) the physician who interprets the films should have or be given, a statement regarding the history, physical findings, and the result of tuberculin test if available (4) serial films will yield more definite information than a single examination and will help to rule out non-tuberculous lesions, and (5) two types of lesions should be looked for the parenchymal and the tracheobronchial Pleural effusion, atelectasis and obstructive emphysema will be found in some instances

G E BURCH M D

TUMORS (DIAGNOSIS)

Traumatic Localization of a Tumor Metastasis (?) M Richard Schweiz. med Wchnschr July 10 1937, 67, 649-650

A case report of a man in whom an injury to the wrist seemed to lead to the localization there of a hypernephromatous metastasis (primary not found) The further study of the case showed however, that the metastasis must have been present before the injury

L G JACOBS M D

Microscopic Grading of Tumors Its Interpretation Limitations, and Relation to Radiosensitivity Wilham Carpenter MacCarty Am Jour Roentgenol and Rad Ther March 1937 37, 365-367

Microscopic grading and sensitivity conclusions must not be drawn prematurely for there is no microscopic grading or classification which has absolute value in clinical prognosis, even though Broders' grading will lead to fewer errors In each tumor there are to be considered lymph node involvement, fixation, size and duration of growth anatomical location, renal and cardiac efficiency, absence of anemia, lymphocytic infiltration, fibrosis, hyalinization, and cellular differentiation

S M ATKINS M D

An Apparently Solitary Myeloma P Gruness Röntgenpraxis, March, 1937, 9, 190-192

Multiple areas of bone destruction are typical of myelomas. Single solitary myelomas have been described in the literature only rarely The diagnosis of multiple myeloma is at times quite difficult especially its differentiation from carcinomatous metastases When only a single myelomatous area of bone destruction is shown, the diagnosis is still more difficult

In the author's case a roentgenogram of the chest showed a well circumscribed area of increased density in the base of the right chest and a tumor mass which surrounded an area of destruction in the seventh rib, which was well localized and cystic The roentgen diagnosis was metastatic carcinoma or myeloma At autopsy it was found that the lesion was a plasma-cell myeloma with a few other very small foci in the skull and sternum which were not shown radiographically

HANS W HEFKE M D

The Differential Diagnosis of Mediastinal Tumors. N Lloyd Rusby Proc Roy Soc Med Sect Med, August, 1937, 30, 1205-1208

Rusby points out that in the differential diagnosis of mediastinal tumor, a detailed radiological examination is of greatest service This includes postero-anterior, lateral, and oblique views of the chest as well as fluoroscopic screening Contrast media, such as lipiodol are often useful The possibilities of radiological examination are not yet exhausted Such an examination can be combined with certain other procedures to elicit facts of the greatest value, such as the introduction of artificial pneumothorax to show the relationship of the mass to the pleural space and whether it lies within or outside of the lung substance Introduction of air into cystic tumors has aided in their differentiation from pleural fluid

W A SODEMAN M D

TUMORS (THERAPY)

Radiotherapeutic Experiences in Malignant Tumors of the Upper Respiratory and Digestive Tracts with Regional Lymph Node Involvement A Pagani Strahlentherapie, 1937, 59, 575

The author reviewed 150 cases of tumors of the mesopharynx observed during the period from 1929 to 1935 at the Roentgen Institute of Schinz The localization

RADIATION INJURIES

Clinic and Therapy of Professional Injuries Due to Roentgen Rays F F Freund *Strahlentherapie*, 1937, 58, 694

The author briefly reviews the history of roentgen injuries occurring in individuals who come in contact with them professionally. The first typical symptom of a chronic roentgen poisoning is a drop in the leukocytes with a relative increase in the lymphocytes. The prognosis is usually good if the changes are recognized early and if complete protection from radiation from then on is afforded. The treatment consists of physical exercise and sojourns in higher altitudes. Arsenic and pyramidon are contra indicated.

ERNST A POHLE M D Ph D

Injuries Following Bucky" Irradiation F Kalz *Strahlentherapie*, 1937, 59, 547

The assumption of Bucky that skin injuries of a serious nature will not occur if very soft roentgen rays (Grenz) are used, is not correct. Although there have been no ulcers described during a period of 15 years, changes like atrophies and telangiectases have been observed by a number of radiologists. Depending on the penetration of the radiation these skin injuries will occur after doses of from 1,600 (H V L 0.034) to 4,000 r (H V L 0.016). There also seems to be a difference in sensitivity in different parts of the body. Highly sensitive are the eyelids and surrounding parts as well as the lateral cervical areas. The author then reports five cases showing late injuries after Grenz ray exposure consisting of telangiectasis, depigmentation and one case with pigmentation as seen in lentigo. The conclusion therefore is obvious. Accurate determination of the dose and careful observation of the upper safe limits are indicated.

ERNST A POHLE M D Ph D

Radiation Tumors Hans Hellner *München. med. Wchnschr.* June 18, 1937, 84, 980-984

While human radiation cancer is in some sort an experimental cancer, similar lesions in laboratory animals are rather infrequently reported. The author notes a decline in reported human cases especially when the increased use of x-ray is considered. The time from first irradiation to a diagnosis of cancer is about ten years. Every case was frequently and heavily irradiated usually by several physicians. The author's cases are briefly described as to location and treatment.

The author feels that the tumor theory of Bernhard Fischer-Wasels best explains roentgen carcinoma. Roentgen sarcoma is rarer than roentgen carcinoma and often occurs after continued intensive irradiation of joint tuberculosis. As a rule it occurs from five to seven years after the irradiation. The tuberculosis has apparently a secondary etiological role. The epiphyses were especially sensitive and histologically the tumors in his cases were osteochondrofibrosarcomas. He re-

ports a case of roentgen sarcoma occurring in the hand after irradiation eleven years previously for joint tuberculosis.

Experimental radium sarcomas of the soft parts have long since been recognized, workers undertaking to produce such tumors in the lower end of the femur of rabbits. Success resulted in one case with repeated doses of radium over two years to the knee. The author feels that these facts should lead to caution in the irradiation of joint tuberculosis and of other conditions in the epiphyseal, especially of the knee.

L G JACOBS, M D

How does Necrotic Roentgen Ulcer Develop? B Dahl *Strahlentherapie* 1937, 59, 522

The pathogenesis of the roentgen ulcer is not known. The author studied, therefore, the skin reaction in rats and frogs histologically following the application of destructive doses of roentgen rays (3,000-4,000 r). He concludes that in the development of the roentgen ulcer two different factors must be recognized: the direct injury of the cells and the subsequent secondary reaction in the blood vessels. The edema in the capillaries hinders the blood circulation in the connective tissue which will, therefore, undergo necrosis. This process may continue and extend into deeper layers of tissue. Regeneration and repair will take place only if the connective tissue and blood vessels regain their faculty to form granulation tissue.

ERNST A POHLE, M D, Ph D

Radiation Cancer in Radiologists A Beclère *Strahlentherapie* 1937, 60, 9

This is the first paper in Volume 60 of *Strahlentherapie* which is dedicated as 'Festschrift' to its editor, Prof H Meyer of Bremen, in honor of his sixtieth birthday. The Nestor of the French radiologists discusses the changes occurring in the skin of radiologists following continued and excessive exposure to radiation. His article closes with a note of warning: Do not underestimate the seriousness of even early changes in the skin because carcinomatous degeneration sets in early and the sooner these lesions are radically removed the better is the chance for a cure.

ERNST A POHLE, M D, Ph D

THE SPINE

Perirenal Insufflation Aubry and Bertrand-Guy *Bull. et Mém. Soc. Radiol. Méd. de France* February, 1937, 25, 133-135

The classical method of approach for insufflation of the perirenal capsule is to place the needle from 15 to 20 mm. before below, and to the side of the transverse process of the second lumbar vertebra.

The authors employ the same technique as for splanchnic anesthesia. With the patient seated the needle is introduced at the lower border of the twelfth rib, 7 cm. from the midline on the right, 4 cm. on the left incli-

ual tumor It cannot be emphasized too strongly that complete clinical and roentgenographic information is necessary and that individual tumors may vary in response

S M ATKINS M D

Röntgen Therapy of Superficial Tumors P Ott Strahlentherapie 1937, 59, 189

In view of the fact that many techniques are used in the treatment of superficial malignancies the author undertook a systematic study of this problem Following a brief historical sketch he describes the apparatus used by him in his studies Four different types of x-ray tubes were available One could be operated at 10-40 kv 3 ma one at 40-75 kv 3 ma, one at 60 kv, 2 ma and one at 60-150 kv 6 ma The potential was furnished by transformers with valve tubes and condensers He gives data on the output of the various tubes depth dose percentages determined in a water phantom and compares these with the doses obtained from radon screens The back scatter for various field sizes was also determined

It appeared that no routine method can be recommended for the treatment of superficial malignancies but the method or methods must be selected for each individual patient in order to obtain good results There is no question but that superficial tumors may react favorably to heavy doses of roentgen rays However it is impossible to state at this time whether roentgen rays or radium would produce the best end results Eight illustrative case reports are appended to the article with photographs showing the lesions before and after treatment

ERNST A POHLE M D Ph D

Enormous Tumor of the Breast Treated and Cured by X rays Filtered through Three Millimeters Aluminum Only M T Nogier Bull et Mém Soc Radiol Med de France January 1937 25, 91-93

In September 1930 a woman 78 years of age with a breast tumor 14 X 10 X 6 cm freely movable and without clinical metastases but draining pus from three large sinuses was treated with x rays by the author Technie Coolidge tube, 3 mm aluminum filter 30 cm STD, 25 cm point spark gap 1100 R (Solomon) Three large fields were treated at three day intervals and a second series was given after two months Primary regression of the tumor was remarkable

In June 1934 recurrence at the site of one of the fistulas occurred with a small axillary node in evidence A similar series dosage 1900 R with 8 cm fields to the breast and two doses of 1,900 R and 800 R to the axillary nodule were given in September 1934 The recurrent and axillary nodules disappeared and in November, 1936 the patient now 84 years of age was free of recurrence

S RICHARD BEATTY M D

Indications for the Treatment of Malignant Tumors of Skin, Mouth, and Larynx H Th Schreus Strahlentherapie 1937 60, 178

The indications given by the author are essentially the same as accepted by American radiologists with one principal difference While in this country it is considered preferable to use radon implantation for many intra oral tumors the author uses, whenever possible the technique developed by Chaoul namely, roentgen rays applied at a very short focal skin distance

ERNST A POHLE M D Ph D

The Experience in Zürich with the Irradiation of Malignant Tumors of the Glandular Organs in the Abdomen Excluding Gonads (1919-1935) H R. Schinz Strahlentherapie, 1937 60, 170

This is a résumé of the results obtained in the treatment of malignant tumors of the glandular abdominal organs published in detail in book form by the author in collaboration with Zuppinger The many statistics given in the paper cannot be abstracted suffice it to say therefore that a total of 244 cases of this type were seen of which 146 were males and 98 females, the average age amounted to 51.3 years At the time of writing the report 12 were still free from symptoms, which corresponds to 5 per cent After a three year observation period six, or 2 per cent died Palliation was obtained in 85 patients (38 per cent) The average duration of life of all uncured patients was 9.4 months

ERNST A POHLE M D Ph D

Application of Ultra short Waves with Special Regard to Malignant Tumors W A G van Everdingen Acta Radiologica, August, 1937, 18, 559-563

The influence of ultra short waves on malignant tissue of mice was studied The author discusses an objective method for measuring and controlling thermoelectrically the rise of temperature of the test animal during the irradiation He failed to find any action other than the diathermal one

G E BURCH M D

ULTRA-VIOLET LIGHT

Are Exposures to Ultra violet and Sun Radiation Dangerous? G Miescher Strahlentherapie 1937 60, 134

The author has studied the changes which occur following continuous exposure to ultra violet and sun rays in animals especially with the possibility of producing cancer He concludes that there is no reason to warn against light and sun exposure if sharp reactions are avoided Our experience from animal experiments indicates that the face should be protected during general body exposure

ERNST A POHLE, M D Ph D

THE THYROID

Roentgen Treatment of Exophthalmic Goiter O Raagaard Ugesk f læger April 29 1937 99, 453-459 (Printed by permission from British Med Jour, June 26, 1937 p 103 of Epitome of Current Medical Literature)

The author draws attention to the lack of unanimity as to the respective merits of radiological and other treatment for Graves' disease. Of late in Denmark the value of radiological treatment has been much underestimated, as the impression that it is more or less an unessential supplement to medicinal treatment is widespread. The author has conducted a follow up study of 68 definite cases which were given radiological treatment ambulatory in most cases, between 1922 and 1933 in a Danish hospital. The disease was severe in six cases, moderately severe in 26 and mild or slight in 36. An observation period of from three to eleven and a half years was counted from the conclusion of treatment. In 57 cases the follow up study included a medical examination. Recovery could be claimed in 70.6 per cent, and almost complete recovery in 7.4 per cent. The improved represented 10.3 per cent while 7.4 per cent were unchanged. There was one death from Graves' disease in addition to two deaths from other causes. In 85.3 per cent complete fitness for work was found on re-examination and 5.9 per cent were partially fit. No patient was refused radiological treatment or found to be refractory to it. In 6.4 per cent the goiter disappeared completely. The average duration of treatment was 11.9 months, and the average number of exposures was 7.3. The author's comparison of his experiences with those of radiologists in other countries reveals a certain uniformity in the results achieved. He concludes that radiological treatment produces as good results as does operative therapy.

Malacia of the Neck of the Femur with Combined Degeneration of Hypophysis and Thyroid R. Kienböck Strahlentherapie 1937 60, 115

The author reports a case of a man 54 years old, who was admitted to the hospital in 1936. During the last 14 years he had been steadily gaining weight and recently developed dizziness and nausea with difficulty in walking. At the age of 13 he had a thyroidectomy. The clinical diagnosis was myxedema. Roentgen examination of the hips showed a bilateral juvenile malacia of the neck of the femurs apparently on the basis of an endocrine dysfunction. The patient died from gangrene of the lung shortly after admission. The autopsy revealed myxedema of the entire body, operative defect of the thyroid, and hypoplasia of the hypophysis. The changes shown in the roentgenogram in both hip joints were verified. The author believes that we have to deal with a combination of two types of degeneration produced by endocrine dysfunction, namely, partial infantilism and degeneration of the skeleton on a hypophyseal basis.

ERNST A. POHLE, M.D. Ph.D.

TUBERCULOSIS, PULMONARY

The Problem of Tuberculosis B. P. Potter Jour Am Med Assn, May 8, 1937, 108, 1585-1590

This is an address presenting this problem from the general practitioner's point of view. It is apparent that the finding of frank cases of tuberculosis can be enhanced only by methods of greater precision and by the utilization of a more extensive case-finding program. The wider use of the x-rays and less attention to physical examinations in all patients who consult physicians for symptoms that even in the remotest way suggest the possibility or probability of tuberculosis will be a great step forward.

The practitioner has a part to play in the examination of contacts of the known cases of tuberculosis and as an educator in the larger plan of case finding of individuals with asymptomatic tuberculosis. His influence must be extended to include proper management of the open case, with two things in mind: first, to segregate the patient and second to convert the sputum bacillary by early treatment at home or in the office of those in whom this is possible.

The physician must realize that the earlier appropriate therapeutic measures are applied the sooner the patient ceases to be a menace and the prognosis becomes increasingly more favorable in many instances.

CHARLES G. SUTHERLAND, M.D.

Tuberculous Tracheobronchitis Paul C. Samson, John Barnwell, John Littig, and John C. Bugher Jour Am Med Assn, May 29, 1937, 108, 1850-1855

Since patients whose pulmonary tuberculosis is complicated by tuberculous tracheobronchitis have a relatively grave prognosis, the clinical recognition of this complication should be of concern to all phthisiotherapists. They define the condition as a specific infection of the mucosa or submucosa of the trachea and bronchi and to be distinguished from 'tracheobronchial tuberculosis' which signifies clinical tuberculosis of the tracheobronchial lymph nodes.

The predominant mode of mucosal infection appeared to be direct contact with tubercle bacilli from pulmonary cavities. Microscopically the primary tracheobronchial lesions were either minute ulcers in the mucosa or small tubercles presumably resulting from the deposition of tubercle bacilli in the crypts of mucous glands. With progression of the lesions there were submucosal infiltrations with overlying intact mucosa showing edema and congestion or varying degrees of mucosal ulceration. The lesions were characteristically on the posterolateral walls of the bronchi and trachea further suggesting implantation infection. Occasionally a direct massive extension from a pulmonary cavity to the peribronchial tissue was observed, with subsequent involvement of the mucosa.

As far as the bronchi were concerned, only about one-third of the cases showed evidence that was consistent with a mucosal involvement secondary to tuberculous infection of the peribronchial lymphatics. Out of 49

was 18 per cent, of the 124 Schauta cases 1.5 per cent. The Schauta cases had also a superior percentage of lasting cures—51 per cent, as compared with 36 per cent for the Wertheim cases.

Radium treatment was given in 253 cases, including 51 which were operable. The mean dose was 2,000 mg radium element hours in fractional doses. In the op-

erable cases this treatment led to a single death and lasting cures amounting to 42 per cent. In the inoperable cases (202) there was an 8.5 per cent primary mortality and 16.5 per cent of five year survivals. (The recent radium mortality has been 4 per cent.) Considerable value in prevention of recurrences is ascribed to persistence with post operative x radiations in small dosage.

was as follows soft palate 10 tonsils 49, base of tongue 32, angle of jaw 16, valleculæ 22, mesopharynx wall 21 cases Of the tonsil tumors, 38 were carcinomas and 11 sarcomas Only 24 of all patients admitted were operable The histology of these neoplasms and also some of the clinical features are discussed In two comprehensive tables a synopsis of all treated cases and the end results are given Photographs of a few illustrative cases are appended

The method of choice in treating the primary tumor as well as the regional lymph glands is protracted fractional roentgen therapy applied with low intensity The tumors of the soft palate without metastasis may be seeded or treated by radon molds Small residual tumor masses or local recurrences are treated with radium or are destroyed by electrocoagulation If there is any residual glandular involvement after roentgen therapy, the glands are removed provided that the primary tumor has been completely eradicated Primary resection of the lymph nodes is not recommended Of all cases with tumors of the mesopharynx plus glandular metastasis 25 per cent remained well for three years and 21 per cent for five years The final outcome depends entirely on the stage of the disease when treatment is started and also on the metastases, consequently, the results can be improved only if these cases are diagnosed early

ERNST A. POHLE, M.D., Ph.D.

Radiation Therapy of Malignant Tumors R. du Mesnil de Rochemont *Strahlentherapie*, 1937, 60, 120

The success of radiation therapy of tumors depends on the stage of the disease, its localization, the character of the tumor and proper and adequate radiation technique The rôle of the time factor in radiation therapy has been discussed in detail during the last few years and undoubtedly valuable information has been gained Homogeneous distribution of the dose in the entire diseased area is of the greatest importance and the author analyzes the factors which influence it The advantages and disadvantages of the use of very short focal skin distances are also discussed

ERNST A. POHLE, M.D., Ph.D.

Endometrioma M. Rocmans and Petitfrère *Bruxelles med* May 2 1937 17, 1001-1006 (Reprinted by permission from *British Med Jour*, July 31, 1937, p. 20 of *Epitome of Current Medical Literature*)

The authors define an endometrioma as a tumor which possesses the characteristics of endometrium but which occupies an abnormal position. It occurs most often in young women and may be situated in various regions Two cases are reported in one of which the tumor was on the upper part of the broad ligament and in the other it was adherent to the recto-vaginal septum In the first case the patient had suffered from pain in the right iliac fossa for four years This pain which radiated to the right hip and the lumbar region became se-

vere enough to necessitate operation A tumor the size of a large nut was removed from the broad ligament, and was found on microscopical examination to have the characteristics of an endometrioma In the second case the patient had complained of indigestion for three years particularly at her menstrual periods, with vomiting and lumbar pain Appendectomy, together with the removal of the left adnexa, was carried out, and a small cystic nodule was felt in the pouch of Douglas but was not removed owing to adhesions A year later this tumor had grown and was adherent to the posterior vaginal wall and the adjacent tissues There were symptoms of tenesmus and some menstrual irregularity A posterior colpotomy was performed, which gave access to the tumor It was found to be an endometrioma but was too adherent to be removed

Two tubes of radium were inserted, and a month later menstruation became normal, the symptoms disappeared and the size of the tumor began to decrease The origin of these tumors is discussed and the various theories which have been put forward are considered The method of treatment must vary according to the localization and fixity of the tumor, the age of the patient, and the risk of injuring the reproductive organs

The Chorionepithelioma of the Male O. Jüngling *Strahlentherapie*, 1937, 60, 86

The author observed two cases of chorionepithelioma in the male One patient was 27 years old, had tuberculosis of the lungs five years before, and had been treated for tuberculous peritonitis Six months before admission he developed shortness of breath and bloody sputum which led to the diagnosis of tuberculosis X-ray examination of the lung, however showed miliary metastases distributed through the entire chest and careful examination revealed that this was secondary to a tumor of the right testicle which histologically turned out to be a chorionepithelioma Several treatments with high voltage roentgen rays were without benefit and did not delay the fatal outcome The second patient was 26 years old and developed pain in the back radiating into the right thigh eight weeks previous to admission A retroperitoneal tumor which apparently originated from a small tumor in the right testicle was found Histological examination proved this to be a chorionepithelioma There were numerous metastases throughout both lungs The Aschheim-Zondek test in the urine was positive The tumor in the abdomen was entirely resistant to roentgen rays The patient died shortly afterward with metastases in the brain The differential diagnosis between this tumor and the seminoma is discussed

ERNST A. POHLE, M.D., Ph.D.

The Relative Importance of Histological Analysis in Tumor Therapy Ferdinand C. Helwig *Am Jour Roentgenol and Rad Ther*, March, 1937, 37, 358-364

Histologic analysis provides but a portion of the data necessary for the intelligent treatment of each individ-

Obviously, little progress can be made until the mechanism of this reaction is better understood. It has been known for the toxic symptoms consisting of anorexia, vomiting, diarrhea, and death which followed the application of heavy doses of

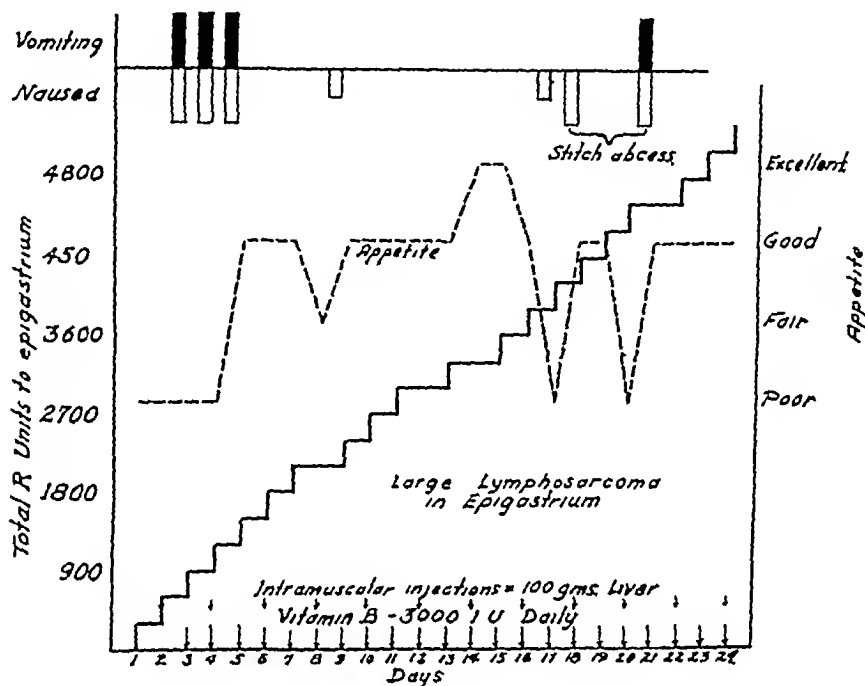


Fig 1 In this case a large tumor overlying the head of the pancreas completely blocked the common bile duct and a drainage tube had been placed in the gall bladder. Although liver extract was started on the second day nausea and vomiting followed each x-ray treatment until two days after vitamin B₁ was started. Improvement in appetite was then marked except for a few days when a stitch abscess appeared and was opened.

years that "true irradiation sickness," severe enough to require treatment, results only when certain portions of the body are irradiated. In our opinion some portion of the intestinal tract or the parotid gland must be included in the treated area for serious symptoms to be produced. We also believe that areas treated over the upper abdomen produce more severe symptoms than those treated over the lower abdomen because the intestine becomes more sensitive as it approaches the stomach. Although little has been written about the effect of x-rays on the parotid, we have found it possible to eliminate most of the untoward effects following irradiation of the head and neck by efficiently shielding these very sensitive structures. Hall and Whipple (2), in 1919, described

filtered x-rays to the abdomen in dogs. In an article (3) published in 1920, one of us (C. L. M.) showed that a similar reaction characterized by loss of weight, a reduction in urine output, diarrhea, anorexia, and eventual death could be produced in rabbits *only* when some portion of the abdomen was irradiated. These findings were substantiated in 1922 by Warren and Whipple (4), who found it possible to produce their severe reactions in dogs only when some portion of the abdomen was irradiated. They described microscopic changes in the small bowel, consisting of more or less complete necrosis of the epithelium of the crypts and villi, which they thought were of great significance. In fact, they concluded that the intoxications observed in their animals were due to

Sensitization of the Skin to Ultra violet Light Fr Bering *Strahlentherapie*, 1937, 60, 16

This is a preliminary report as to the effect of certain food diseases, and chemical agents on the reaction of the human skin to ultra violet light The author found, for instance that in the second and third stages of syphilis the susceptibility is increased, while during the latent period normal reactions were observed A number of drugs were also tried, protosil decreased the susceptibility, salvarsan increased it Experiments studying the effect of others are under way

ERNST A POHLE M D Ph D

URETHRA (CANCER OF)

Carcinoma of the Female Urethra Case Report, with Summary and Review of the Literature T P Sparks Jr, and W H Parsons *Urol and Cutan Rev*, March 1937 41, 157-163 (Reprinted by permission from *British Med Jour* May 1, 1937, page 72 of *Epitome of Current Medical Literature*)

The authors have collected 119 cases from the literature as well as a personal one in a patient, 75 years of age, in whom the growth was successfully excised They state that carcinoma of the female urethra though uncommon is not so rare as the number of reported cases would suggest The ages of the patients ranged from 26 to 75 the average age being 54 Of the group (119), 15 survived three or more years after treatment 39 received surgical treatment alone, and of these two lived three years and one five years after operation Of 40 treated by radium or deep x-ray therapy six survived three years or more and five were living at the end of five years Of 21 treated by a combination of some surgical procedure with radium or deep x-ray therapy, seven lived three years or longer and five lived five years or longer after treatment Of 17 with demonstrable glandular involvement at the time of treatment six were treated by operation only and one survived three years, seven by radiation alone and none survived as long as three years, three by a combination of operation and radiation, and two survived three years or longer—one nine years One patient had no treatment

The prognosis in carcinoma of the female urethra is exceedingly poor, though not hopeless The authors conclude that desiderata for successful treatment are examination of all patients with painful micturition early diagnosis of the malignant type, and complete excision in the early stage

THE UTERUS

Some Considerations in the Treatment of Carcinoma of the Cervix by Irradiation A Pickhan *Strahlen therapie*, 1937 60, 505

Following a brief discussion of the biologic and physical principles underlying radiation therapy in carcinoma of the cervix, the author outlines the technique practised in his clinic In the first two groups roentgen deep

therapy is given as a supplementary treatment to radium application In addition to from 7,000 to 8,000 mg hr, a total surface dose of 3,500 r is used In Groups III and IV roentgen therapy is used almost exclusively except that vaginal radium application is used whenever feasible A statistical analysis of 1 536 cases seen during the period from 1926 to 1935 showed that 54 per cent of all patients who successfully completed the primary course of treatments were still free from recurrence after 10 years, while the corresponding figure for Group I alone was 69 per cent

ERNST A POHLE, M D Ph D

Has Our Discard of Operative Therapy in Uterine Fibroids and Preclimacteric Metropathies Proved to be Good Practice? C J Gauss *Strahlentherapie*, 1937, 60, 401

The author analyzes in this paper 1,048 cases of uterine fibroids and preclimacteric uterine bleeding, which had been treated by radiation His indications were to subject only such cases to treatment as had definite symptoms requiring attention For operation, he considered only a few types of uterine fibroids, as, for instance, submucous, pedunculated subserous, and infected fibroids The statistical analysis showed that 93 patients were operated on and the remaining 955 were irradiated Roentgen rays alone were used in 711 patients, radium alone in 160, and roentgen rays and radium in 16 patients There was no mortality among those radiated and 43 per cent in those operated on A careful follow-up of the treated cases led the author to the final conclusion that uterine fibroids and preclimacteric metropathies are better irradiated unless there are very definite contra indications

ERNST A POHLE M D Ph D

Therapy of Cancer of Uterine Cervix at Gynecologic Clinic in Kiel from Oct 1 1922 to Dec 31, 1930 R Schröder *Zentralbl f Gynäk* March 6, 1937 61, 546-563 (Reprinted by permission from *British Med Jour*, May 29 1937, p 1144 of *Epitome of Current Medical Literature*)

The author gives an account of treatment of carcinoma of the cervix and its results in a series of 604 cases (1922-1930) in which a five year supervision was subsequently possible Absolute cure in the sense of a five-year survival in good health was obtained in 171, or 28 per cent Increasingly good judgment in selection in the mode of treatment for particular cases together with increasing experience in all treatments, seemed to bring about an improvement in the results for the last three years (1928-1930) 327 cases had 34 per cent of five-year cures For the whole period the operability rate was 58 per cent The cases actually operated on totalled 50 per cent Wertheim's operation was usually done in the first and Schauta's vaginal wide hysterectomy in the second half of the period under review The primary mortality of the 178 Wertheim cases

with a huge number of barbituric acid derivatives, but they are all capable of producing sleep and depressing the vomiting

cutaneously or intravenously, produce marked improvement in the toxemia resulting from intestinal obstruction. Since,

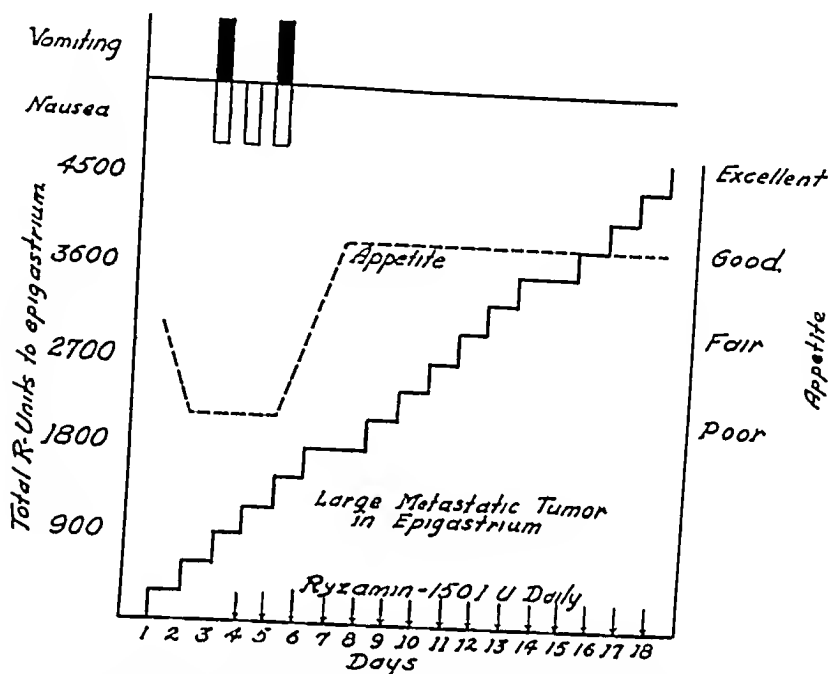


Fig 3 This patient had a large metastatic tumor in one of the mesenteries of the upper abdomen. She received 300 r daily through large ports of entry and complained of nausea and vomiting until two days after vitamin B₁ therapy was started. Her appetite then improved and she had no further trouble.

center in most individuals. Some of the preparations now available are amytal, phenobarbital (luminal), ortal, ipral, neonal, allonal, nembutal, nemburial, seconal, and veronal. Many of these drugs are sold in the form of sodium salts which are soluble in water, and, therefore, suitable for rectal administration in solution. Some of them are made up in the form of suppositories which are very valuable in the presence of vomiting. Richards and Peters (7) have called attention to the fact that barbiturates are contra-indicated in the presence of liver disease, and we have encountered a few cases in which a marked excitement followed their use, but in most instances their palliative effect is quite satisfactory.

Haden and Orr (8) showed very conclusively some twelve years ago that sodium chloride solutions, given either sub-

according to our theory, many irradiation reactions are toxemias resulting from intestinal damage, it seems reasonable to assume that the same type of therapy might be successful, and many authors have advocated the use of sodium chloride. Patients who are vomiting need food and water as well, and our best results have been obtained from the intravenous administration of a liter of 5 or 10 per cent glucose made up in normal salt solution. This medication can be given repeatedly and is particularly helpful in the treatment of cases having abdominal masses which are producing partial intestinal obstruction. Holmes and Hunter believe that a high carbohydrate intake is very helpful, and give their patients stick candy and fruit drinks containing large amounts of lactose, in addition to intravenous glucose.

Intravenous medication is not a simple

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IRRADIATION SICKNESS¹

By CHARLES L. MARTIN, E E, M D, F A C R, and WALTER H. MOURSUND, JR, A B, M D, Dallas, Texas

Radiological Department, Baylor Medical School

PATIENTS receiving heavy doses of irradiation frequently develop anorexia, malaise, nausea, and vomiting. Holmes and Hunter (1) have described three different types of this indisposition: first, "toxic sickness" resulting from the destruction of large masses of tumor tissues; second, "psychic sickness" produced by the association of the odors of the radiological department with a real reaction which has occurred at a previous visit; third, "true irradiation sickness" which is the symptom-complex resulting from the effects of x-rays or radium rays on the normal structures of the body. This paper deals only with true irradiation sickness, which has become increasingly important with the adoption of fractional doses and prolonged periods of treatment. Since very little is known about the cause of this condition, a great deal has been written about it. A perusal of the literature of the past thirty-three years shows that more than thirty authors have at one time or another championed one or more of the following etiological factors:

- 1 Inhalation of nitrous gases and ozone in the treatment room
- 2 The building up of static electricity in the patient's body
- 3 Changes in sodium, calcium, and potassium metabolism

- 4 Disturbances in chlorine metabolism
- 5 Changes in the vegetative nervous system
- 6 Changes in blood cholesterol
- 7 Cholin poisoning
- 8 Glycogen dwindling
- 9 Endocrine imbalance
- 10 Allergic phenomena
- 11 Disturbance of acid base equilibrium
- 12 The production of a roentgen toxin in the blood
- 13 Stimulation of enzymes which produce tissue autolysis

Since such a variety of causes has been assigned to this troublesome malady, one is not surprised to discover that many plans of treatment have been recommended and many authors feel that their remedies may be specific. Some of the substances recommended are: intravenous saline solution (isotonic to 10 per cent), intravenous glucose solution (5 to 25 per cent), sodium chloride, calcium chloride, afenil, colsil, vasano, nautisan, permesin, ephetonin, sympatal, cardiazol-ephedrine, insuhn, hypophyseal and suprarenal extracts, a resistant strain of colon bacilli, magnesium hyposulphite, intravenous magnesium thiosulphate, intramuscular liver extract, and nembutal.

¹ Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13-17, 1937.

B₁, a substance made from rice polishings by Burroughs-Wellcome, Betaxin, made by the Winthrop Company, and Vitamin of vitamin B₁. Betaxin is put up as a

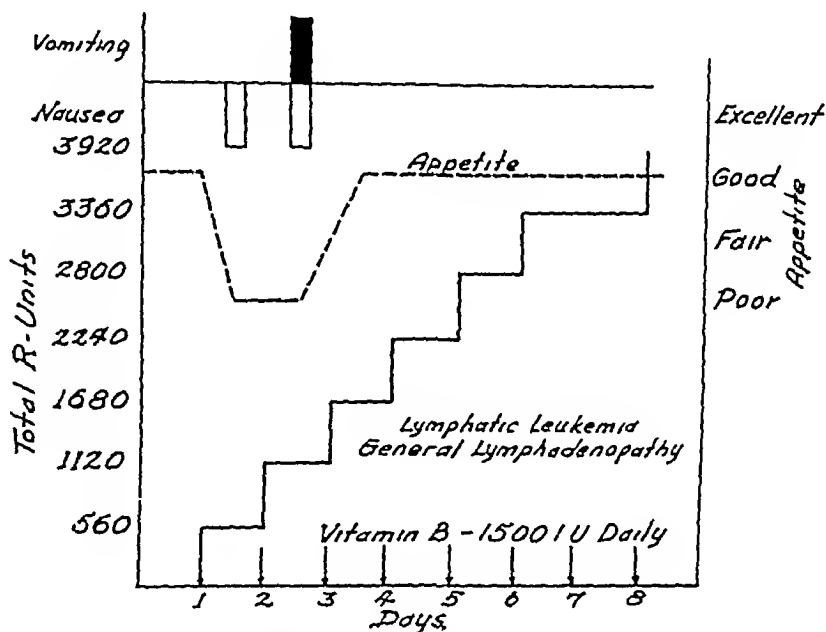


Fig 6 Although 560 r was given to large groups of leukemic glands on successive days, no gastro intestinal symptoms were noted after the vitamin B₁ therapy was continued for two days

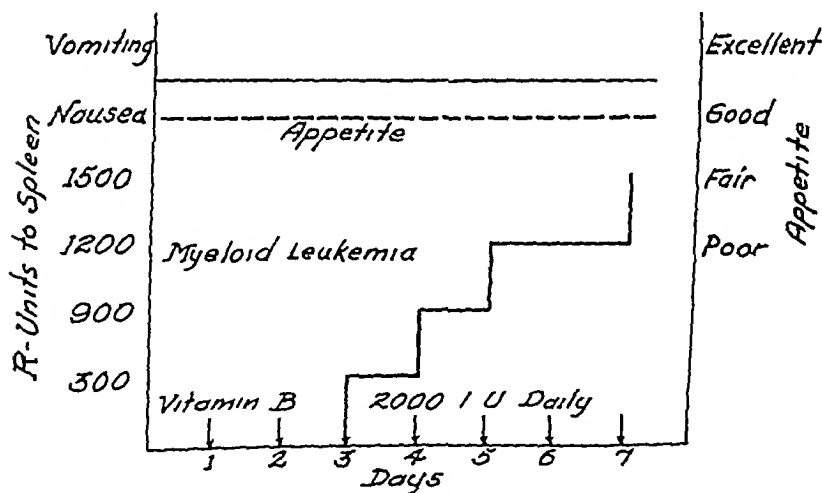


Fig 7 Severe reactions can be expected regularly when 300 r is given daily to a very large spleen through 20 cm ports in myelogenous leukemia. In this case the vitamin B₁ was started two days in advance of the x ray treatment and no gastro-intestinal symptoms were noted at any time

B₁, made by Abbott & Company Ry-zamin-B is put up in a sweet syrup-like mixture in a flexible tube and the amount

tablet containing 500 international units and in fluid form as a 1,000 I U ampule for intramuscular injection. The tablet manu-

injury produced in the epithelium of the small intestine Martin and Rogers (5, 6) later studied the cachexias produced in dogs

We began by experimenting with drugs capable of depressing the vomiting center and thereby relieving nausea and vomiting

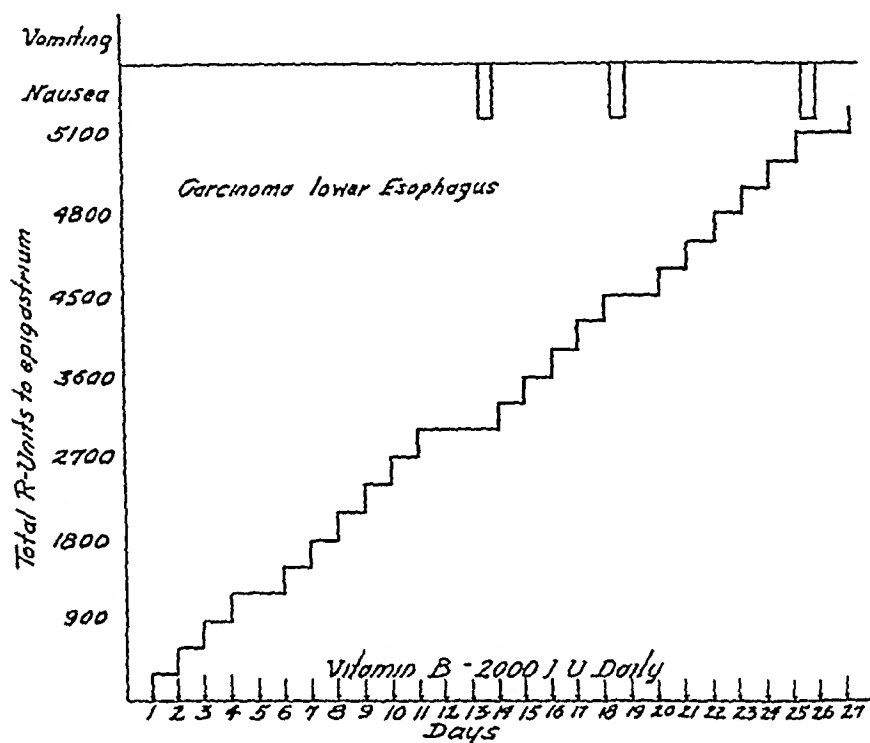


Fig 2 In this case a large carcinoma partially blocked the lower esophagus and extended into the fundus of the stomach and a gastrostomy had been done. Although 300 r was directed through a 15 cm port almost every day toward the epigastrium, using 220 kv and a heavy Thoraeus filter, very little nausea and no vomiting occurred.

by administering heavy doses of x-rays to isolated loops of small bowel, and published a photograph of the dilated discolored loops of small intestine observed in a dog dying from the effects of a very intense dose of x-rays given to the entire abdomen. A few years later an attempt was made by the same authors to study the intoxication produced by irradiation of the parotid but none of the laboratory animals showed reactions following such irradiation and it was soon learned that the parotid glands of small animals do not respond like those of the human species.

Since we were convinced many years ago that true irradiation sickness was in most instances produced by an interference with intestinal physiology, we have searched for remedies capable of counteracting functional disturbances of the intestinal tract

temporarily, some ten years ago, knowing, of course, that these remedies served only to relieve symptoms and were in no way specific. At first the best results were obtained with chloral hydrate and the bromides, but even when 20 gr of chloral hydrate and 60 gr of sodium bromide, a rather heroic dose, were given by rectum, symptoms were often alleviated for only two or three hours. Our attention was then shifted to barbitol which produced a more lasting effect, and about six years ago amytal was adopted in our clinic as the best available remedy. This substance was given in doses varying from 3 to 10 gr depending upon the age of the patient and the severity of the symptoms, and long remissions resulted. Of course, depression and stupor may result from this form of therapy. The drug market is now flooded

lasted for several weeks. Since in these cases vitamin therapy had been begun on the first day of irradiation it occurred to us that several days were required for the body to become saturated with the substance. For this reason 2,000 I U are now given daily for at least two days before the x-ray treatment is started and we feel that this procedure has definitely minimized the symptoms noted during the early period. That saturation is necessary for relief is also indicated by the fact that when vomiting occurs it can frequently be relieved almost immediately by the intramuscular injection of 2,000 I U of vitamin B₁.

More than fifty patients receiving irradiation for a variety of conditions have been treated with vitamin B₁, but it is our opinion that case reports should be limited to those cases receiving x-ray treatment over the upper abdomen because some degree of sickness can be expected regularly following this procedure. Our clinical experience with ten such cases is tabulated in Table I. In none of these patients except the last one was preliminary vitamin B₁ therapy used, but the results obtained with this case were so good that we believe most of the patients could have been relieved of their early symptoms if the plan had been used throughout the series.

In our clinic the following routine orders for patients about to undergo heavy irradiation has been adopted:

- 1 A high carbohydrate diet
- 2 Vitamin B₁, 2,000 I U daily by mouth beginning two days before the irradiation is started
- 3 If vomiting occurs, give vitamin B₁, 2,000 I U, intramuscularly at once
- 4 If relief does not occur within 30 minutes, give sodium amytal, gr VI, or an equal amount of another soluble barbituric acid derivative by rectum, or insert a nembutal suppository
- 5 If vomiting persists, give one liter of

5 per cent glucose in normal salt solution intravenously, and repeat if necessary

We have not found it necessary to give intravenous glucose to any of the patients treated with vitamin B₁. As a rule this medication is needed only when some serious complication such as partial intestinal obstruction or abdominal infection is present.

SUMMARY

1 Barbiturates and intravenous saline and glucose solutions have a definite palliative effect on irradiation sickness

2 Vitamin B₁ given in large doses often prevents all the symptoms and seems to have a more specific effect

BIBLIOGRAPHY

- (1) HOLMES G W and HUNTER FRANCIS T The Management of Roentgen Sickness. *New Eng Jour Med* Aug 15 1935 213, 308-310
- (2) HALL C C and WHIPPLE G H Roentgen ray Intoxication. Disturbances in Metabolism Produced by Deep Massive Doses of the Hard Roentgen Rays. *Am Jour Med Sci* April, 1919 157, 453-482
- (3) DENIS W and MARTIN C L A Study of the Relative Toxic Effects Produced by Regional Radiation. *Am Jour Med Sci*, October, 1920 160, 555
- (4) WARREN, S L, and WHIPPLE G H Roentgen ray Intoxication. *Jour Exper Med*, Feb 1, 1922, 35, 187-203
- (5) MARTIN C L and ROGERS, F T Intestinal Reaction to the Erythema Dose. *Am Jour Roentgenol and Rad Ther* January 1923, 10, 11-19
- (6) Idem Roentgen ray Cachexia. *Am Jour Roentgenol and Rad Ther* March 1924, 11, 280-286
- (7) RICHARDS G E and PETERS M V Numbness in the Treatment of Radiation Sickness. *Am Jour Roentgenol and Rad Ther* April 1936 35, 522-525
- (8) HADEN R L, and ORR THOMAS G Obstruction of the Jejunum. *Arch Surg* 1925 11, 859-882
- (9) POPP, W C Nausea and Vomiting Following Roentgenologic Treatment. *Proc Staff Meet Mayo Clinic* April 1, 1936 11, 222-223
- (10) DAVIS, E E Is Colitis a Deficiency Disease? *Trans Am Proc. Soc.* 1934, 35, 93-96
- (11) RUSSELL W R. Parenteral Administration of Vitamin B₁ in the Treatment of Polyneuritis and Other Conditions. *Edinburgh Med. Jour*, May 1936 43, 315-323
- (12) DIETEL, I G, and PROBST V The Mode of Origin and Treatment of Symptoms Following Roentgen Irradiation. *Strahlentherapie* 1935 52, 270-281
- (13) YOUNG, B R. Liver Extract as a Remedy for Roentgen Sickness. *Am Jour Roentgenol and Rad Ther*, May, 1936, 35, 681-681
- (14) COLLAZO, J A., and SÁNCHEZ RODRIGUEZ, J Vitamin B₂ and Injectable Hepatic Extract. *Klin. Wchnschr* May 19, 1934, 13, 736

procedure nor is it entirely pleasant, and the irradiation therapist would like to have at his command some efficient preventive which could be given by mouth without the production of untoward symptoms. Nembutal, as recommended by Richards and Peters and Popp (9), is easy to administer but it does not really strike at the cause of the toxemia and it keeps the patient in a state of drowsiness.

In casting about for substances which play a rôle in intestinal derangements, our attention during the past year has been drawn to vitamin B. Davis (10) states that a lack of vitamin B₁ produces anorexia and degenerative changes in the intestinal tract, consisting of reduction in the size of the villi, decreased absorptive capacity, decreased vigor of the intestinal musculature, and vascular and trophic changes in the mucosa, while a lack of vitamin B₂ produces vague digestive upsets, diarrhea, and pellagra. The similarity between these symptoms and findings and those observed in animals receiving large doses of x-rays over the abdomen is at once apparent. Russell (11) and others have reported a marked improvement in appetite after the administration of vitamin B₁ in such serious diseases as pernicious anemia and sprue, and Dietel and Probst (12) and Young (13) have produced some encouraging results in irradiation sickness by the intramuscular injection of liver extract. Although many workers claim that this substance contains vitamin B₂, Collazo and Sánchez Rodríguez (14) feel that their experiments show that the common hepatic extracts contain only vitamin B₁.

Since the chloride of vitamin B₁ can now be obtained in pure crystalline form for both oral and intramuscular use we felt its effectiveness should be investigated. A series of animal experiments was first carried out in an effort to show that this substance might be capable of producing protection against the lethal abdominal dose of x-rays. From this work, which has been reported elsewhere, we learned that although small animals could not be uniformly protected, large doses of vitamin B₁

seemed to definitely prolong the lives of some of them.

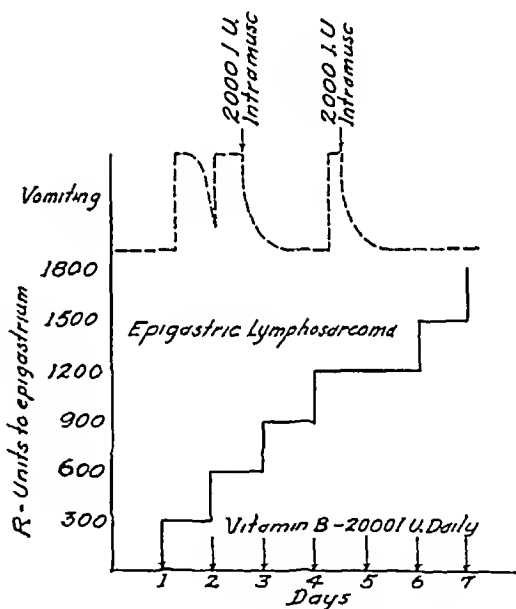
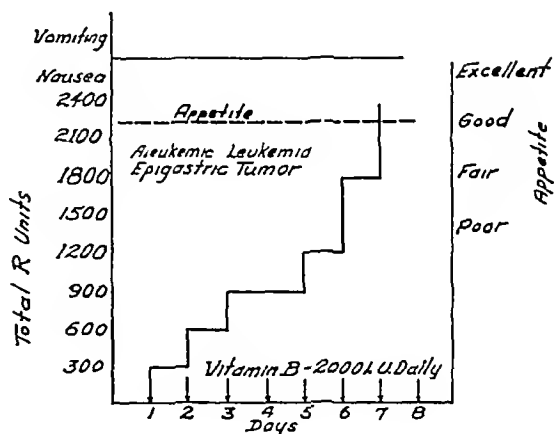
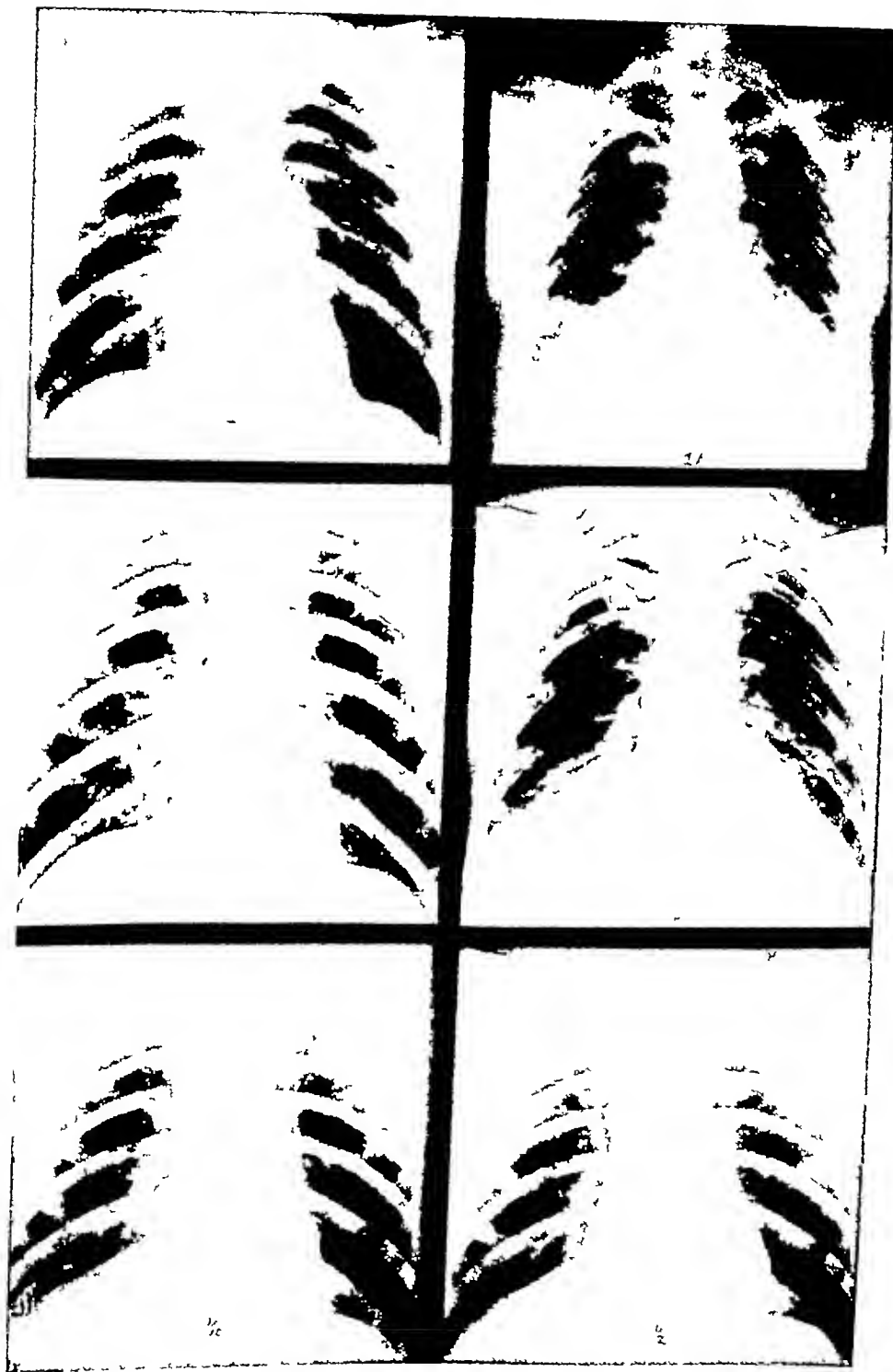


Fig 4 (above) During a previous admission when she received exactly the same x-ray treatment over the epigastrium this patient was quite ill during the entire series. However, although the tumor was equally as large, at this visit she had no gastro-intestinal symptoms and was quite comfortable.

Fig 5 (below) On two occasions this patient had an attack of vomiting after an x-ray treatment while taking vitamin B₁ by mouth. Intramuscular injections of the vitamin stopped the vomiting instantly both times.

It was then thought worthwhile to try the substance in clinical practice. The preparations available to us were Ryzamin-



Figures 1 to 6 illustrate the normal chest (of the author) taken during the inspiratory and expiratory cycle. The variety of techniques are the methods routinely employed for this purpose by many physicians and radiologists. Fig 1 (*upper left*) Inspiration ($\frac{1}{20}$ sec 6 ft FTD 62 kv 400 ma) Fig 2 (*upper right*) Expiration ($\frac{1}{20}$ sec 6 ft FTD 67 kv 400 ma) Fig 3 (*middle*

factured by Abbott contains 1,000 I U and their ampule for intramuscular use contains 2,000 I U. At first doses of only form of medication not only reduced or completely abolished all nausea, but it enabled the patients to enjoy most of their

TABLE I

	Diagnosis	Irradiation	Medication	Results
1	Epigastric retroperitoneal lymphosarcoma	300 r daily to one of two 15 cm ports for 20 treatments	Vitamin B ₁ —3,000 I U daily Liver extract 100 gm every second day	Nausea and vomiting during first three days of treatment
2	Large metastatic epigastric tumor from carcinoma of cervix	300 r daily to one of two 20 cm epigastric ports for 16 treatments	Ryzamin — 150 I U Vitamin B ₁ daily after fourth day	Nausea and vomiting stopped on day after vitamin B ₁ started
3	Large epigastric tumor from aleukemic leukemia	300 r daily to one of three 20 cm ports over upper abdomen for six treatments	Vitamin B ₁ —2,000 I U daily sodium amytal gr 3 each night for sleep	Appetite good and no nausea through series
4	Carcinoma of lower third of esophagus	200 r to two 10 X 15 cm areas over upper abdomen and lower chest daily for 20 treatments	Vitamin B ₁ —150 I U daily given as Ryzamin	No nausea Fed through gastrostomy tube
5	Carcinoma of lower third of esophagus and fundus of stomach	200 r to two 10 X 15 cm areas over upper abdomen and lower chest daily for 20 treatments	Vitamin B ₁ —1,500 I U daily through gastrostomy tube	Only slight nausea and no vomiting
6	Carcinoma of lower third of esophagus and fundus of stomach	300 r daily to one of three 15 cm areas over abdomen and lower chest for 24 treatments	Vitamin B ₁ —4,000 I U daily through gastrostomy tube	Slight nausea on three occasions No vomiting
7	Large epigastric tumor from Hodgkin's disease with common duct blocked	300 r daily to one of three 15 X 20 cm areas over epigastrium for six treatments	Vitamin B ₁ —2,000 I U daily Sodium amytal gr 6 some nights for sleep	Vomited once after each of first three treatments Appetite good throughout series
8	Large epigastric tumor secondary to lymphosarcoma of rectum	300 r daily over one of three 20 cm areas over upper abdomen for six treatments	Vitamin B ₁ —2,000 I U daily Vitamin B ₁ —2,000 I U intramuscularly twice for vomiting	Vomiting after two treatments relieved at once by intramuscular vitamin B ₁
9	Carcinoma of antrum of stomach	300 r daily to one of three 15 cm ports over upper abdomen for 24 treatments	Vitamin B ₁ —2,000 I U daily	Vomiting on one day only Appetite good as at admission
10	Huge spleen from myelogenous leukemia	300 r to one of 20 cm areas over spleen daily for four treatments	Vitamin B ₁ —2,000 I U daily beginning two days before x-ray therapy	No nausea Ate three good meals daily throughout series

150 I U per day were used, but we were soon convinced that larger doses were more effective and at present many patients are receiving 2,000 I U daily. The drug is given by mouth and intramuscular injection is resorted to only when vomiting occurs. We were soon convinced that this

meals and to maintain their nutrition even while receiving a long series of treatments over the abdomen.

In many instances nausea and vomiting occurred during the first few days of treatment but completely disappeared during the remainder of the period which often

examination projects the normal and abnormal thoracic densities upon a film true to size, shape, and outline, and devoid of

cannot be placed upon the absolute requisite of a perfect x-ray exposure film, one that can be reproduced year after year,

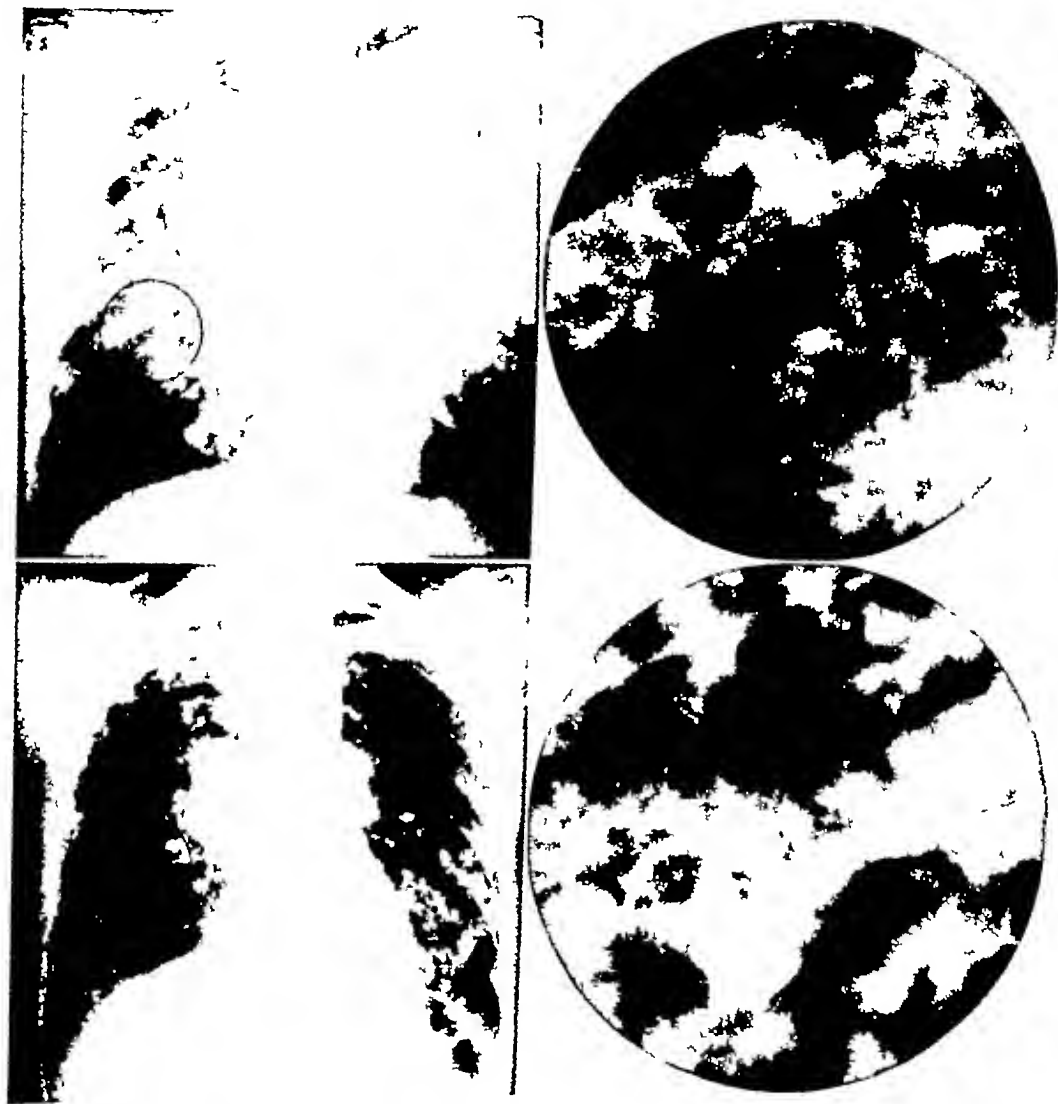


Fig 7 (above) illustrates a moderately advanced case of blastomycosis with accompanying enlargement shown in Figure 8 (right)

Fig 9 (below) indicates metastatic lung involvements with marked emphysema and an enlargement,

Fig 10 (right) of a one inch circle localized lung-field as marked on the film shown in Figure 9

movement or pulsations of the minute lung structures themselves. Distortion or exaggeration must remain at a minimum. It must be possible to review and differentiate the projected normal and pathological lung structures on a properly exposed x-ray film.

In my opinion too great an emphasis

clearly outlining the most minute lung structure changes, especially during the present diagnostic developmental phase of our problem, otherwise the diagnostic possibilities are of necessity limited.

The minimum requirements for an ideal set-up is an x-ray transformer developing from 400 to 500 milliamper capacity in a

ROENTGENOLOGIC ASPECT OF SILICOSIS¹

By EDWIN C. ERNST, M.D., St. Louis, Mo

From the Department of Radiology of the DePaul Hospital

It has been my observation that there is lacking sufficient appreciation of the important rôle played by roentgenology in the early diagnosis of silicosis of the lung structures. Renewed widespread interest in the unfortunate individuals so afflicted is beginning to be manifested by the medical and legal professions, as well as the industries in which occupational disease is truly an economic problem. I might include also those manufacturing plants in which the non-silica dust problem is but a pseudo-hazard. Nevertheless, the added difficulties of the defense of such unjust claims has created even greater economic chaos, and renewed interest in the scientific and diagnostic phases of this problem is a most timely reaction.

Therefore, my object in stimulating interest in this symposium is due to the self-evident fact of the ever-increasing importance and responsibility of the roentgenological considerations in the early diagnosis of silicosis. I realize, also, the desirability of a group discussion and correlation of the pathological and clinical phases with all of which we roentgenologists should be fully acquainted before finally arriving at the proper differential diagnosis.

The various methods of lung examinations have their individual limitations and the early roentgenological diagnosis of silicosis is no exception. The lungs are formed, as most of you know, by multiple ramifications of the bronchi, bronchioles, and terminal expansion type of bronchioles. From a roentgenological, diagnostic, and prognostic standpoint, these latter terminal bronchioles are very important anatomical structures. The *vestibule*, the three to six *atria*, and the two or more *infundibula* together form the primary units or lobules of a normal lung. Throughout

these primary units or lobules of the lung there are interlaced important superficial deep systems of lymphatics. An important function of this latter deep lymphatic group is to take care of the stray or foreign matter particles while the blood vessels deal with possible noxious substances that may be present in solution. A thorough understanding of these primary units beyond the roots of the lung is fundamental knowledge, the scope of which every radiologist should thoroughly visualize as the final line of defense of the lung against the invasion of foreign substances. This can occur only after the actions of the lined ciliated epithelium and the muscles of the walls of the air passages have failed in their endeavor to protect the lung. Equally so, the roots of the lung in relation to the bronchial lymphatics, glandular and vascular structures should receive intensive study, since they usually show such a variety of connective thickening tissue due to old infections, sinus disease, or abnormal vascular densities, when primarily silica is not the etiological factor. All of these lines of future research will require most intensive study in the direction of correlating the available data in co-operation with the pathological findings of sections of the lung areas involved, and the serial examinations of normal and hazardous lung dust cases—not unlike the pioneer work in tuberculosis so ably conducted by the many workers and members of this Society when the early roentgenologic diagnosis of this disease was at stake. The many physiological and chemical phenomena should be given equal considerations, as well as the most helpful work of our colleagues in the Public Health Service and the mining industries. From a technical roentgenologic standpoint, there is room for improvement in at least two directions. I will discuss some of these problems during the lantern-slide projections.

¹ Read before the Radiological Society of North America, at the Twentieth Annual Meeting at Memphis, Tenn., Dec. 3-7, 1934.

It will be impossible at this time to adequately discuss all of the important requisites of a complete x-ray examination,

diagnosis in questionable cases, or for the exclusion of other types which might simulate silicosis when initially examined



Figs 15 and 16 (above) These present the frequently observed calcified sharply defined nodulations suggestive of healed tuberculosis and the enlargement of a small circumscribed area of the same lung ($5\frac{1}{2} \times$) as shown in Figure 16 (right)

Figs 17 and 18 (below) These illustrate a typical case of acute miliary tuberculosis and the enlargement of an inch circle lung field ($5\frac{1}{2} \times$) as shown in Figure 18 (right)

but an evaluation of a few of the essential requirements will not be amiss. Stereoscopic film studies are always preferable to single exposures, although this method is not always practical. Serial films made at intervals of every six or twelve months are absolutely essential in arriving at a final

Lateral views are always helpful, both in the early and advanced cases of lung dust conditions. Another requisite is taking advantage of a broad knowledge based on experience in differentiating x-ray film shadows of unusual lung patterns, and normal but intensified bronchial markings,

Since I believe the more exacting roentgenological considerations are increasing in their importance in the field of diagnosis of lung dust problems, an introspection as to the position and responsibilities of the roentgenologist will not be amiss. If the x-ray film merely indicated silica as an opaque rock or crystalline foreign body, a simple fluoroscopic examination would suffice. Instead, we find indirect but characteristic evidence of healthy lung reaction opacities to abnormal and continuous inhalation of certain forms of foreign dust particles. Again, these lung changes may vary in proportion to the quantity, rate, and duration of the exposure to silica dust, as well as to the size and type of the particles.

Unfortunately the early or pioneer work in pneumoconiosis was, of necessity, based on x-ray film studies made with portable machines or technical roentgen methods considered unreliable to-day. The true picture of even normal lung structures was incorrectly projected upon the x-ray film, pathological tissue changes were likewise distorted. Therefore, during the period preceding the year 1928 it was to be expected that controversial opinions were expressed regarding the diagnosis of pneumoconiosis, as they were in the roentgen diagnosis of early tuberculosis prior to the World War. Many of you here will remember that it was not uncommon for the inexperienced clinician and some roentgenologists to diagnose incipient tuberculosis in the adult on the basis of intensified or unusually prominent glandular and linear peribronchial and hilar opacities. This was equally true of the silicosis problems prior to the period of intensive research, postmortem studies, and the accumulation of statistical data on large series of cases by several of the scientists who are taking part in this program.

Simple silicosis not complicated by infections or tuberculosis should be roentgenologically diagnosed reasonably early and

with accuracy. In the near future many of the controversial phases should be eliminated in view of the added knowledge and experience based on carefully analyzed histological researches made available for use to-day.

The pathological postmortem studies of Dr. Gardner have been of the greatest help in this direction. During the past three or four years intensive examinations of localized enlargements of suspicious lung-fields on the original x-ray film have been studied and have aided us materially in the diagnosis of extremely early and questionable silicosis. The limits of our efforts at enlargements have been five and a half times the original lung-fields, but apparently this degree of enlargement is sufficient for differential diagnostic purposes. Improved finer grain films and intensifying screen textures may broaden the scope and future practical employment of this method as a research and an accessory diagnostic procedure. The future preliminary education of the physician specializing in the diagnosis of these occupational diseases should include a rather comprehensive practical experience, and by all means include interpretation of various types of lung diseases and the many possible thoracic, mediastinal, and upper respiratory tract complications. Such an experience should not be limited to lung dust examinations alone.

Unquestionably the lung specialist should have studied occupational dust conditions from every possible angle and should have followed the clinical course of the disease from its incipency by means of serial lung studies of known silicosis cases over a period of many years. A most invaluable requisite or background is an unusually broad roentgenological diagnostic experience.

Hand in hand with experience, the practical roentgenologist realizes that there are certain essential technical requirements in order that the correct interpretation of x-ray films may be possible. The ideal x-ray

(left) Inspiration ($1/10$ sec 3 ft F T D, 45 kv 400 ma) Fig 4 (middle right) Expiration ($1/20$ sec 3 ft F T D, 50 kv 400 ma) Fig 5 (lower left) Inspiration ($1/10$ sec 3 ft F T D 78 kv, 100 ma) Fig 6 (lower right) Inspiration ($1/2$ sec, 3 ft F T D 58 kv, 100 ma)

penetration of the chest thus estimated in terms of the number of kilovolts to be employed. Otherwise, the diagnostic value of an improperly exposed x-ray film is misleading and, in fact, unreliable from the standpoint of early diagnosis of any and all types of lung infections as well as silicosis.

The size of the focal spot of the x-ray tube is another important consideration. If too large, the shadows of the chest, including both the normal and the pathological structures, would be greatly exaggerated upon an x-ray film. The broad focal spot might be compared to the large "fast" lens of our present-day speed camera. It is possible to make very rapid exposures in subdued light with such an unusually large lens, but at the expense of depth or detail. If the lens or diaphragm is "stopped-down" to a very small opening, sharper photographs are obtained, but compensated by a longer exposure factor. This is also true when too small a focal spot is employed in the average low capacity x-ray tubes.

The distance of the tube from the film and patient is likewise an important factor. The greater the distance, up to six feet, when a broad target is employed, the more accurate is the projection of the chest image upon the film, but the x-ray beam is less intensive and a larger milliamperage output is required. However, both these greater distances and larger x-ray tube targets have their disadvantages in that an increased quantity of current, or milliamperage, is required. The capacity of the average smaller transformer is inadequate for the ideal rapid exposure technique. After all, the roentgenologist must select a happy medium between distance, voltage, and focal spot, but the time factor, in my opinion, should remain uniform and preferably less than one-twentieth of a second, otherwise, movements or pulsations of the lung structures cannot be excluded. Uniform reduplication of exposures over a period of many years is a most important requirement in serial lung examinations.

Many of our small x-ray machines require that the tube be placed relatively close to the patient and film—perhaps three

feet distant—due to the limited capacity of both the x-ray machine and tube. Usually from one-fourth to one second exposure is required under these conditions, but in the average group of cases, this type of film will unquestionably prove to be very unreliable and misleading from an early x-ray diagnostic recognition standpoint of apical tuberculosis, miliary tuberculosis, fungi diseases, blastomycosis, silicosis, etc. Comparative changes or developments cannot be accurately studied by such limited types or methods of making x-ray examinations. The hazard of movement and distortion of the lung structures can be controlled by one-twentieth second's exposures or less, and thus blurring factor of the lung markings must be eliminated if the x-ray examination is to be considered ideal.

The size or habitus of the patient may show individual comparative lung differences, all of which variations are, however, considered normal for that particular type of chest. Whether the x-ray examination is made during deep inspiration or expiration is also an important factor from an interpretative standpoint. Very frequently we require both types of film in addition to a special study during the phase midway between inspiration and deep expiration in our examinations, especially when emphysematous changes are present. In the past some observers based their early positive silicosis findings on supposed pathognomonic changes of the peribronchial and hilar trunk shadows, but in the light of the most recent observations of serial studies of a large group of suspected cases, I have failed to observe any such typical roentgenological findings other than the basic discrete peripheral six millimeters or less lung densities, showing uniformity as to size and distribution, plus well defined borders surrounded by apparently normal shadows.

However, Dr. Gardner has discussed this matter in detail in relation to the comparative x-ray and pathologic autopsy findings. The more acute type of silicosis produces a somewhat different picture, a dif-

tube containing a target focal spot no greater size than 4.5 millimeters, 6-foot target-film distance, with an exposure time more desirable since the focal spot is but one-third as large as the above minimum requirements, thus projecting the more

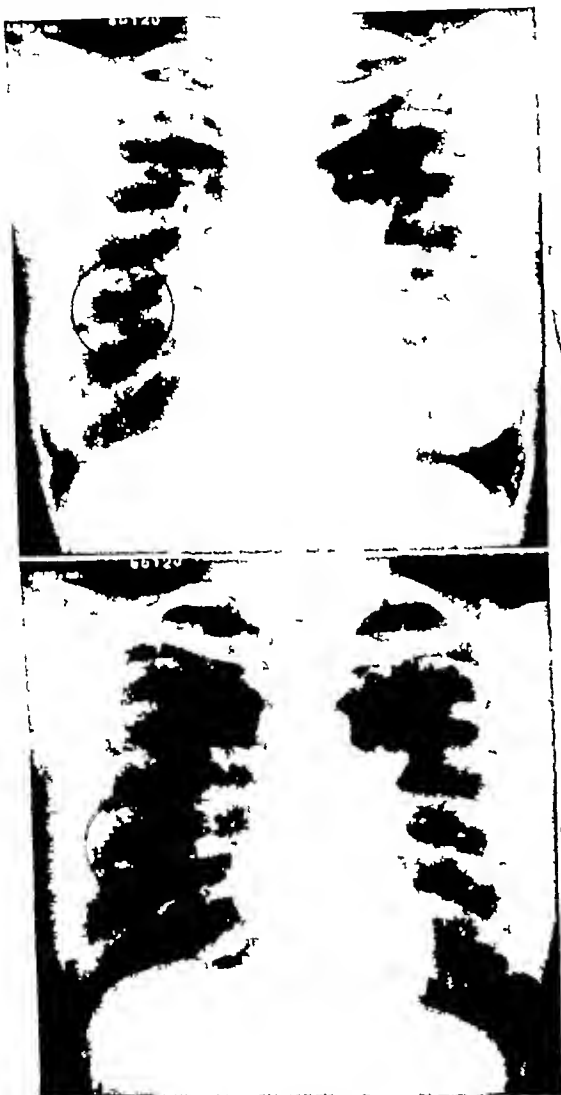


Fig 11 (upper left) This film presents an interesting case (patient Mrs. O. T.) of peripheral thickening and atypical elongated nodulations, somewhat suggestive of miliary tuberculosis. The patient entered the Barnard Free Skin and Cancer Hospital (service of Dr. M. Engman, referred by Dr. C. W. Lane), complaining of a persistent skin eruption throughout the past year involving the lower extremities and later the body and arms as a whole. The biopsy indicated giant cells, necrotic tissue areas and atypical suggestive tuberculous findings.

Fig 12 (upper right) This enlargement ($5\frac{1}{2} \times$) indicates a lower right lung field which is most interesting when compared with a silicotic field enlarged to the same degree.

Fig 13 (lower left) This film shows an examination several months later of the same thorax and, to our surprise, indicated a disappearance of the previously observed nodulations. The patient remained symptom-free with negative clinical findings throughout the chest, and elsewhere, and has remained so for many years. The eruption has disappeared. The final diagnosis was a fungus type of infection. This is the third case of the mycositic type which simulated a silicotic lung.

Fig 14 (lower right) This film indicates an enlargement ($5\frac{1}{2} \times$) of a one inch circle of a lower right lung-field which now appears relatively clear.

of one-twentieth of a second. The new minute lung shadows with even greater detail and accuracy upon the X-ray film

CLINICAL ASPECTS OF SILICOSIS

By A. J. LANZA, M.D., *New York City*

Assistant Medical Director, Metropolitan Life Insurance Company

IN presenting for discussion the clinical aspects of silicosis, it should be remembered that it is essentially a chronic, progressive disease. I am frequently asked by laymen, and occasionally by physicians, "How long does it take for a case of silicosis to develop or to produce disability?" As well ask, How long does it take heart disease to develop, or cirrhosis of the liver, or Bright's disease. We have one advantage with respect to silicosis in that we can watch the progress of the disease by the x-ray. As a result of intensive occupational studies, where workmen have been kept under observation from the time of entrance into the industry, and over a period of years, it has been possible to measure with a fair degree of accuracy the length of exposure necessary to produce definite silicosis, demonstrable by x-ray, under a given, constant set of conditions.

In the Joplin District, in the old days of dry drilling in the mines, five years' continuous exposure, as a rule, produced definite clinical silicosis with appreciable disability, after tubercle infection was demonstrated, death usually resulted in not longer than two years, and in our series of cases, those who developed silicosis were dead, on the average, ten years after commencing work in the mines. These observations were true for that particular set of conditions. Recently, we had the opportunity of examining over 1,000 films of foundry workers, employed in a group of foundries. Here we found definite cases of silicosis among employees who have been working twenty, thirty, forty years, and even longer in the same foundry, and who were still working at their regular eight-hour shifts. Another set of circumstances produces a clinical picture different from the first example, but constant for itself. Between these two extremes lie many vari-

ations in the clinical picture of silicosis, but these variations differ mostly in intensity rather than in type.

Obviously, the underlying cause of these variations in the intensity of silicosis is the dosage of silica which the individual receives. A very heavy dosage produces disease, disability, and death, more rapidly than a light or medium dosage. The dosage, in turn, is dependent on, first, the amount of free silica in the dust inhaled, second, the quantity of dust in the atmosphere breathed, third, the length of exposure of the individual in terms of months and years, and whether he worked steadily or intermittently.

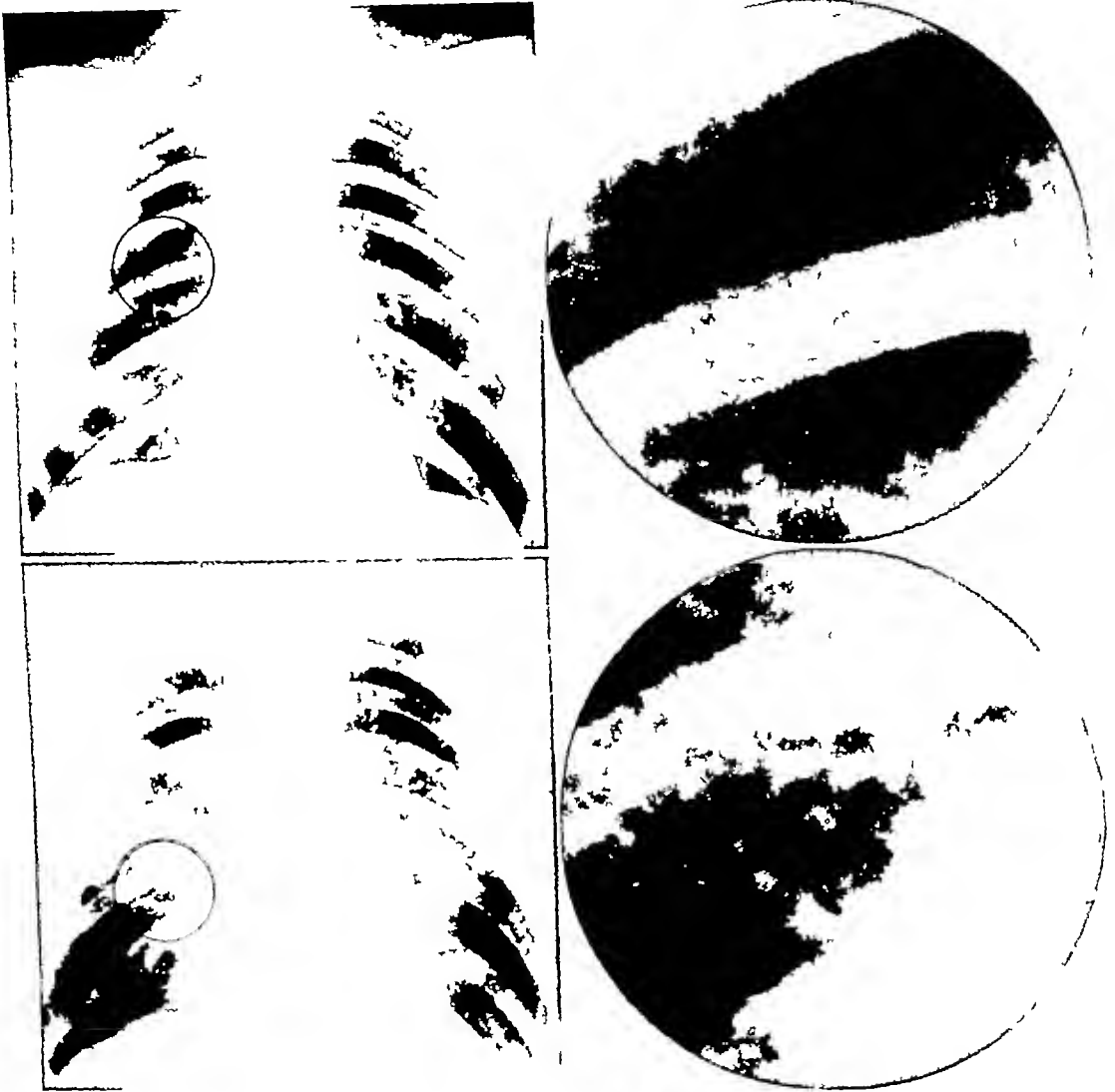
Actually, in industrial practice, we do find numerous variations in these factors, with much resultant confusion in the ideas of those observers who, conversant with one set of conditions, endeavor to reconcile their findings with published reports dealing with an entirely different set of conditions. Variations among those exposed to an identical hazard may result from abnormalities in the individual, chief among which are pre-existent pulmonary disease and syphilis. The experience at the Picher Clinic indicated that individuals with a $4+$ Wassermann contracted silicosis in about one-half the time of normal persons. While this observation has not, I believe, been corroborated elsewhere, I think this is probably because the relationship between silicosis and syphilis has been overlooked.

It is more difficult to make a diagnosis of silicosis, especially in the early stages, in a chance patient encountered in the wards of a metropolitan hospital than when the physician is examining a group of men in an industry and is familiar with the nature and extent of the hazard and with the different occupations of his patients.

Most of our knowledge of silicosis is con-

from those unusual lung structure projections, and peripheral reactions or congestions, which are pathological yet not due to silicosis

structures are too light, the necessary lung detail is lost, dark or over-developed films are of little diagnostic value, for early lesions may be overlooked. The potential



Figs 19 and 20 (*above*) These illustrate a normal healthy lung and the accompanying enlargement ($5\frac{1}{2} \times$) as shown in Figure 20 (*right*)

Figs 21 and 22 (*below*) These show a nodulated lung-field with a minimum amount of silicosis, involving the peripheral lung structures. It is interesting to study the enlargements of these cases as shown in Figure 22 ($5\frac{1}{2} \times$) from a differential diagnostic standpoint (*right*)

Space will not permit me to show all of the various stages of silicotic nodulations. I have examined hundreds of questionable lung-fields by this enlargement method and found them to be most helpful from a differential diagnostic standpoint.

The technical considerations, in my opinion, are vital issues and therefore require a most critical analysis from the standpoint of the x-ray examination of the thorax. If the film shadows of the lung

current employed or strength of the x-ray beam is likewise important and should be accurately calculated for each chest examined. The patient should be carefully measured in centimeters and the probable

LOGY

tainly all the published reports bear witness to the almost inevitable tuberculous infection

Prognosis —Once silicosis is established, the prognosis is bad. The disease tends to progress even after exposure is terminated, and sooner or later infection closes the picture. While occasionally one sees a patient with both silicosis and tuberculosis, living on for years, like an old arrested case of uncomplicated tuberculosis, these are the exceptions. Pneumonia is, naturally, a very serious matter for the silicotic patient

fuse intra-pulmonary haziness of uniform density, and must not be confused with the more chronic involvements under consideration in this presentation. The importance of serial examinations in relation to any acute lung condition cannot be over-emphasized. Occasionally the immediate analysis may be difficult but later films easily clear up the differential diagnosis and establish the presence of other lung complications. Various lung and vascular congestions that might grossly simulate early silicosis, including miliary tuberculosis, fungi infections, diffuse bronchial disturbances, asthmatic and bronchiectatic disturbances, must all be excluded in the final analysis by serial x-ray studies. Time will not permit me to discuss the silicotic conditions complicated by infection, since the x-ray and clinical studies may not infrequently require different types of examinations other than those discussed heretofore.

In closing, I wish to again emphasize the desirability of standard technical requirements, or shall I say minimum requirements of the ideal x-ray study for all lung conditions, including silicosis.

Let me again reiterate that the first six films (Figs 1 to 6) are x-ray studies of the same chest, my own, and that all of these exposures were made within a thirty-day period. At least three of the chest films

do not appear alike. In fact, there are such wide variations in the character of the lung markings that many who viewed the original films concluded that they represented the lungs of different individuals. The technic was different for each individual chest examination, but the method was not unlike those routinely employed by many hospitals, offices, and medical departments of some of our industries. Three types of transformers and three different tubes were used in combination so as to obtain the greatest amount of efficiency and maximum capacity within the bounds of safety to the apparatus. The films, screens, and developing factors remained uniform. Therefore, this should prove conclusively the danger of attempting an early diagnosis of abnormal lung dust conditions, unless the x-ray film examination is known to be technically perfect according to the minimum standard requirements, which, I believe, are essential for interpretative purposes.

In addition, these x-ray findings must be correlated with the type of employment, concentration, and character of the dust, length of exposure, and the history and clinical observations, only under these conditions should a final conclusion as to the presence or absence of abnormal lung dust conditions be considered reliable and conclusive.

lished studies in this country and abroad indicates very little in the way of cardiac disease due to silicosis. You do not see large hearts in the x-ray films. Often you do see the small hanging heart associated with tuberculosis. Theoretically, if silicotics do not become infected, they should succumb to right heart failure. Possibly when we have become more familiar with industries or occupations in which the hazard is mild, we may find in men exposed for many years a tendency to disability from heart involvement. However, cer-

sequent upon experience gained in the metal mining industry, in which the hazard was severe (South Africa might well be termed the cradle of our modern experience, followed later by England, the United States, Australia, and Canada.)

The reports emanating from the mining districts in these countries are comparable to a remarkable degree, and the variations in the clinical picture are in direct proportion to the amount of free silica present, modified in later years by the development of protective and preventive regulations. We know a great deal about the symptoms, progress, and prognosis of what Dr Gardner once called "classical silicosis," resulting from exposure to a moderately or very severe hazard. We are not so well informed with respect to those industries or occupations in which the hazard is less intense, where, we might say, the amount of free silica in the dust ranges from 10 to 25 per cent, and where the quantity of dust is not so excessive. In the former, the clinical picture is clear cut and dramatic and it can't be overlooked, especially if you study it at the point of origin. In the latter, the clinical picture may be indefinite or hazy, so that a diagnosis is made only after a resultant tuberculosis has called attention to the pulmonary condition, or in cases in which one is making routine examinations of groups of apparently well men known to be exposed to some degree of silica dust inhalation. With respect to so-called classical silicosis, the general experience is that, barring accidents, the victims nearly always die of tuberculosis, and the more intense the silica exposure, the sooner does tuberculosis result and the more rapidly does it progress. Statistics of the dusty trades indicate that even when the silica dust hazard is comparatively mild, the tuberculosis mortality is above the average.

The principal and distinctive symptom of silicosis is dyspnea, even in cases in which the exposure is severe, dyspnea comes on insidiously. The silicotic patient, in the early stages of his disease, will tell you that he notices a gradually increasing short wind and a corresponding decrease in

working ability, especially if he is engaged on piece or contract work. He notices an increased tendency to catch cold, and has an irritative, unproductive cough. He looks well and feels well when not exerting himself, and may show a tendency to put on weight. A physical examination at this point will show nothing except, perhaps, weakened breath sounds. His condition may progress to total disability from dyspnea, but usually before that point is reached, especially if the silica exposure has been severe, he lights up a tuberculous infection. When this occurs, one of two things may happen: the change may be sudden and dramatic—the patient seems to go to pieces—loss of weight, fever, night-sweats, copious expectoration, rapid loss of strength, and death in a few months. In other cases, a tuberculous infection progresses slowly and it is sometimes difficult to tell whether or not an advanced silicotic is tuberculous. Usually, the x-ray will give definite information. Moist râles following cough usually indicate infection, but there may be much tuberculous involvement with no bacilli in the sputum and nothing definite on examination.

In advanced silicosis, the dyspnea is extreme. All the accessory muscles of respiration are brought into play in an effort to expand the chest and admit air into the lungs—a demonstration that, once seen, is not forgotten. At the same time, there is no cyanosis, the general appearance may be fairly good, and the stethoscope will give little or no clue to the real condition. Only the x-ray will reveal the structural damage to the pulmonary tissue.

Many silicotics complain of various, and mostly vague, gastro-intestinal symptoms. A considerable number, in our experience, state that they have spit up blood, but true pulmonary hemorrhage is probably not frequent in the absence of tubercle infection. The blood pressure has no particular significance except that it tends to diminish with the progress of tuberculosis. Some cases first become clinically manifest following pneumonia.

The experience of those who have pub-

TABLE I—OCCUPATIONAL ENVIRONMENT

Uses of Silica	Types of Silica Used
Abrasive uses	
In scouring and polishing soaps and powders	Quartz quartzite flint, chert, sandstone, sand tripoli, and diatomaceous earth, all in finely ground state
In sandpaper	Quartz quartzite flint, sandstone, and sand, coarsely ground and closely sized
In sand blast work	Quartz quartzite, sandstone and sand, crushed into sharp angular grains uniform in size
Metal buffing, burnishing and polishing	Ground tripoli and other forms of ground silica
For sawing and polishing marble, granite, etc.	Sharp clean sand graded into various sizes
As whitestones grindstones bulirstones, pulp stones oilstones, etc	
Tube mill lining	Massive sandstone from very fine to moderately coarse grained
Lithographers' graining sand	Chert flint, and quartzite in dense, solid blocks
Tube mill grinding pebbles	Medium to fine sand or rather coarsely ground silica and tripoli
In tooth powders and pastes	Rounded flint pebbles
Wood polishing and finishing	Various forms of pure silica finely ground
Refractory uses	All forms of silica ground to medium fineness
In making silica fire brick and other refractories	Fairly pure quartzite known as gannister, not less than 97 per cent SiO_2 , nor more than 0.40 per cent alkalis tightly interlocking grains desired
Metallurgical uses	
In making silicon ferrosilicon, and silicon alloy, of other metals such as copper	Moderately pure sand massive crystalline quartz sand stone quartzite or chert
As a flux in smelting basic ores	Massive quartz and quartzite.
Foundry mold wash	Ground sandstone quartz, and tripoli
Foundry parting sand	Fine sand and ground tripoli
Chemical industries	
As a lining for acid towers	Massive quartz or quartzite
As a filtering medium	Massive diatomaceous earth and tripoli, sand finely granular quartz or quartzite finely ground tripoli, diatomaceous earth and other forms of silica
	Pure pulverized quartz sand, pure tripoli, and diatomaceous earth
	Pure quartz sand
	Finely ground crystalline quartz, quartzite and flint, also finely ground sandstone sand, and tripoli
	Finely ground crystalline quartz, quartzite flint tripoli and other types of ground silica
In the manufacture of sodium silicate	
In the manufacture of carborundum	
Paint As an inert extender	Finely ground silica of all types
Mineral fillers As a wood filler	
In fertilizers	
In insecticides	
As a filler in rubber hard rubber pressed and molded goods, phonograph records etc	Flint, tripoli and chert and other amorphous silica preferred also all other forms of very pure silica all finely ground
In road asphalt surfacing mixtures	Pure quartz sand
Ceramic uses In the pottery industry as an ingredient of bodies and glazes	Very pure massive quartz preferred
In the manufacture of ordinary glass	
In the manufacture of fused quartz chemical apparatus such as tubes, crucibles and dishes	Rock crystal amethyst rose quartz citrine quartz smoky quartz, chrysoprase agate chalcedony opal onyx sardonyx jasper etc
Decorative materials In the manufacture of gems crystal balls table tops vases statues etc	Massive and ground diatomaceous earth
Insulation	Do
Heat insulation for pipes boilers furnaces kilns etc	Moderately pure sharp angular sand preferably finer than 20 mesh together with a small percentage of finely pulverized silica
Sound insulation in walls, between floors etc	Clear colorless, flawless rock crystal or massive crystallized quartz
Structural materials Sand lime brick	
Optical quartz For the manufacture of lenses and accessories for optical apparatus	

is stable at temperatures below 573 degrees C, and high quartz is stable between 573 and 870 degrees C. At temperatures below 573 degrees C, high quartz spontaneously

changes to low quartz, so that, practically speaking, distinction between the two classes is of little importance. Probably the next most common form in which free

THE ETIOLOGY OF SILICOSIS¹

By R R SAYERS, M D, Surgeon, and R R JONES, M D, Past Assistant Surgeon, U S Public Health Service, Washington, D C

THE importance attached to the silicosis problem may be thought of as due to three chief causes (1) Silica occurs extensively in Nature and is widely used in industry, resulting in the exposure of a large percentage of the industrial population, (2) once silicosis is well established, there is no known treatment capable of restoring normal respiratory function, and in advanced cases there is a definite tendency for them to grow progressively worse, regardless of the measures taken for their relief, (3) individuals suffering from silicosis are particularly susceptible to tuberculosis, so that prevention of silicosis should materially reduce the general morbidity and mortality rates due to pulmonary tuberculosis

It is an axiomatic principle that accurate knowledge concerning the etiology of any disease is a prerequisite to its effectual prevention, diagnosis, and treatment. A certain amount of general information relative to the pathology resulting from the inhalation of dusts has been in existence since the time of Hippocrates (430 B C). Some of the early writers discussed such diseases of the lung under the general term pneumoconiosis. Professor Collis (1), in his 1915 Milroy lectures, furnished us with an excellent historical review of the subject of industrial pneumoconioses. However, it was only late in the nineteenth and early in the twentieth century that clinical and experimental studies were carried out, the results of which have yielded rather definite knowledge concerning the causes of silicosis. Rovida (2), in 1871, used the term silicosis in reporting a case of pneumoconiosis, in which he determined that the condition was due to silica, by chemical examination of the lungs

According to the committee on Pneumoconiosis of the American Public Health Association (3),

"Silicosis is a disease due to the breathing of air containing free silica. It is characterized anatomically by generalized fibrotic changes and milary nodulation in both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, absence of fever, increased susceptibility to tuberculosis (some or all of which may be present), and by characteristic x-ray findings."

Although other dusts, when inhaled in sufficient concentrations over a long enough period of time, have been shown capable of producing a definite pulmonary fibrosis, nevertheless, the pneumoconiosis characterized by nodular fibrosis has to date been shown clinically and experimentally to be associated only with the inhalation of dusts containing silica. Moreover, it has been established beyond a doubt that exposure to dusts consisting wholly of free silica (quartz) produces this disease, which has not been shown to be the case for any other specific dust. For this reason, the present discussion is limited to the pulmonary fibrosis resulting from the inhalation of free silica dust.

Silica in Nature—Silica is the most abundant constituent of the minerals and rocks that make up the crust of the earth. It occurs in two forms, free and combined. The free silicas as a group are definite compounds in the form of SiO_2 , the combined forms are spoken of as silicates. Of free silicas which occur in nature, that known as quartz is by far the most common. Quartz is a hard mineral and chemically resistant to reagents, it is an abundant constituent of granite, schist, and other rocks, and the chief component of sandstone and quartzite. Many ores are deposited in veins that consist nearly wholly of quartz. This form of free silica exists in two polymorphous forms, low and high quartz. Low quartz

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TABLE II—SIZE-FREQUENCY DISTRIBUTION OF VARIOUS INDUSTRIAL DUSTS AS COMPARED TO OUTDOOR DUST

Kind of Dust	Num ber of Sam- ples	Me- dian	Average Frequency in per cent—Size Group in Microns											
			0 to 0.10	0.5 to 0.99	1.0 to 1.49	1.5 to 1.99	2.0 to 2.49	2.5 to 2.99	3.0 to 3.49	3.5 to 3.99	4.0 to 4.49	4.5 to 4.99	5.0 to 5.49	5.5 to 5.99
Outdoor dust	170	0.5	56.0	41.0	2.5	0.5								
Sandblasting	9	1.4	1.4	19.7	34.7	20.3	12.6	5.2	2.8	1.6	1.1	0.2	0.2	0.2
Granite cutting	1	1.4	2.0	19.0	33.6	24.5	10.4	4.6	3.1	6	9	3	1.0	
Trap rock milling														
Crusher house	1	1.4	0	13.0	39.0	33.0	10.5	2.5	2.0					
Screen house	1	1.3	2.0	31.5	33.0	16.0	10.0	4.5	2.5	5				
Disk crusher	1	0	10.0	48.0	31.0	6.0	3.0	1.0	1.0					
Foundry parting compound														
General foundry air	2	1.1	0.5	22.0	42.0	17.3	9.2	5.0	1.5	2.0	5			
Talc milling	1	1.2	0	26.0	48.0	17.0	8.0	1.0						
Slate milling	1	1.5	0	16.0	32.0	20.0	13.0	7.0	5.0	2.0	2.0	2.0	0	1.0
Marble cutting	1	1.7	1.0	13.0	29.0	17.0	14.0	14.0	6.0	4.0	1.0	0	1.0	
Soapstone dust	1	1.5	0	12.0	37.0	21.0	10.0	11.0	3.0	0	1.0	2.0	2.0	1.0
Aluminum dust	2	2.4	1.2	16.0	19.0	13.0	11.0	8.0	6.5	4.5	5.5	3.3	2.5	11.5
Bronze dust	1	2.2	3.0	8.0	20.5	14.0	11.5	9.0	6.5	3.0	3.5	4.0	7.0	10.0

cells we know that they usually are unable to handle bodies greater than ten microns in their greatest dimensions. The natural defenses of the respiratory tract probably prevent many particles larger than ten microns ever reaching the finer divisions of the lung, and such as do are likely to be expelled with the bronchial secretions. The soluble silica plays a definite part in the production of the disease, and the size of the particle also affects the rate of solution, due to the fact that the smaller the particles the greater the total surface area exposed to the action of solvents.

Table II shows the size distribution of various industrial dusts as compared with the dust particles observed in the outdoor air in the general atmosphere. It is found that about 70 per cent of the particles found in industrial dusts generally are between 0.5 and 3 microns in diameter. Frequently there are, no doubt, many times as many particles too small to count by the method used, but experimentally it has been shown that a great percentage of such sub-microscopic particles are not retained in the lungs but pass out with the expired air. Sayers (12) has shown that less than 15 per cent is retained when the finer particulate matter, such as lead in the form of fumes, is inhaled. The greater majority of

particles found upon microscopic examination of the lung also fall within the limits of from 1 to 3 microns.

Another reason for considering the size of the particles as affecting the harmfulness of the dust, is that it is the larger ones that settle out rapidly while the rate of falling for the smaller particles is very slow. Figure 1 illustrates graphically this difference, those under 1 micron fall (specific gravity, 2 or 3) at a rate of from one to three feet per hour, while a particle of 5 microns in diameter (specific gravity about 7) falls about 60 feet per hour. Particles of more than 10 microns would settle out with relative rapidity. The fact that the finer particles practically remain suspended in the atmosphere for such periods greatly increases their chance of being inhaled.

Thus we may say from the viewpoint of etiology that the harmfulness of a given dust containing free silica is directly influenced by the number of particles it contains of free silica less than 10 microns in diameter, and probably the greatest harm is produced by those between 1 and 3 microns.

The relationship of dust concentration and duration of exposure are closely associated in their etiologic significance. The rate at which silicosis will develop, ex-

silica exists in nature is the amorphous hydrated form known as opal ($\text{SiO}_2 \cdot \text{H}_2\text{O}$). Opal, which is a silica of colloidal origin and occurs abundantly in the diatomaceous earths, is less resistant to reagents than quartz. Another type of free silica frequently found is flint, and with flint is found chalcedony, a waxy translucent form of silica interpreted as consisting of fibers of quartz with a small amount of interstitial opal. Other forms of free silica occurring less abundantly in nature are tridymite, cristobalite, and siliceous glass or vitreous silica.

Occupational Exposure to Silica—Owing to the fact that the earth's crust contains so great an amount of silica, it is obvious that those occupations concerned with the driving of tunnels, development of highways, mining, and the like are frequently associated with a silicosis hazard. A second class of occupations exposing the workers to this hazard are those connected with industries that have to do with the processing and industrial use of mineral products, such as the smelting and refining of ores, the use of sand and gravel for structural purposes, the carving of stone, particularly granite, the manufacture and use of abrasives and the processing of the various forms of free silica. According to Knopf (4), the most common forms of free silica used industrially are massive crystalline quartz, quartzite, sandstone, flint, tripoli, diatomaceous earths, and silica sand. Table I, from Ladoo (5), illustrates the great variety of uses to which silica is put in industry, and the kind of silica adapted to each purpose.

In a recent survey (6) carried on in a large manufacturing center, it was found that about 9 per cent of the industrial workers were employed in occupations in which the silica hazard required consideration. According to the census for 1930, there were gainfully employed in the manufacturing and mechanical industries in this country approximately 14,000,000 persons. If the above survey can be accepted as representative of the occupational distribution of these workers, it appears that there are nearly 1,200,000 individuals po-

tentially exposed to a silicosis hazard in the manufacturing and mechanical industries alone. Lanza and Vane (7), in their discussion concerning the prevalence and effect of silicosis, state as follows: "Our very rough, but obviously conservative, estimate of the number of workers exposed to silica dust to a harmful degree in the United States is, therefore, upwards of 500,000."

Factors Influencing the Action of Silica Dust Particles as the Exciting Cause of Silicosis—Although it has been shown that silica is the exciting cause of silicosis, there are certain factors which must be considered as influencing its action. Early workers were inclined to consider that the injury produced by the dust particle was due to the mechanical irritation produced by its hard and cutting edges. Gardner (8) has shown experimentally that the inhalation of finely divided carborundum dust, of a greater hardness than silica particles, does not produce the nodular reaction characteristic of silicosis. Collis (9) was one of the early workers to draw our attention to the chemical action of dust. Gye and Kettle (10) have shown that silica in solution or non-crystalline form exerts a toxic action upon the tissues which leads to the proliferation of fibroblastic cells. Lately Miller and Sayers (11) have reported results of experimental studies which illustrate clearly the reaction of peritoneal tissues to certain dusts. Only the silica-containing dusts have uniformly produced a proliferative reaction. Other dusts have been either completely absorbed, leaving no scar tissue, or have remained unaltered in the form in which they were injected. These latter reactions are classed as absorptive or inert.

Since dust, to exert its harmful action, must enter the finer divisions of the lung, the particle size of the atmospheric dust bears a definite relationship to the injurious effect produced. The silica must be present in the air in particles small enough to enter the finer air spaces, and of such dimensions that the phagocytic cells may engulf them. From our knowledge of these

Picher Clinic (16), of the Tri-State District of Oklahoma, Kansas, and Missouri lead and zinc mines, which is a co-operative undertaking, by agents of the operators, the Metropolitan Life Insurance Company, the Bureau of Mines, and the Public Health Service, have shown clearly the effects of various periods of exposure to silica as met with in the mining processes carried out in the district. Similar studies upon the health of granite workers (17 and 18) likewise stress the duration of exposure necessary to produce definite degrees of silicosis.

Some authors have expressed the opinion that the presence of other inorganic dusts in the silica-containing atmosphere may tend to influence the effects of the silica inhaled. The exact action of these accompanying dusts remains to be determined. Heffernan (19) reported the absence of silicosis among a group of employees in a granite brick manufacturing establishment, where the material used contained more than 80 per cent silica. However, before we may consider this as evidence that, as he suggests, the presence of other inorganic dusts along with the silica prevented the harmful silica reaction, there are several bits of additional information which must be supplied. First, he did not show that the men were really exposed to harmful concentrations of free silica. In the manufacture of these bricks, the initial step includes the wet mixing of the materials and it is possible that sufficient exhaust ventilation was maintained to prevent the dispersion of free silica into the atmosphere. In fact, Dr Heffernan states that the atmosphere of the workroom where this process was carried on was quite free from dust. Later operations were of such a nature that much of the free silica which may have been present would become fused or otherwise modified to such an extent that little free silica was available. Laboratory studies to determine the concentration and chemical and physical properties of the dust in the air these men breathed would aid greatly in the scientific interpretation of this report.

Some have thought that the relative

absence of silicosis in the cement industry was due to the calcium present. However, investigations (19) have led to the belief that the absence of evidence of extensive pulmonary fibrosis among employees in the cement industry is due to the fact that there is insufficient total exposure to free silica (considering concentration of dust and duration of exposure) rather than that there is any neutralizing effect due to the calcium.

Again, the various peritoneal reactions to different inorganic dusts, as reported by Miller and Sayers (11), rather definitely suggests that the determining factor responsible for the action of each dust is dependent upon the amount of free silica present and not upon the presence or absence of other dusts.

No complete reports of pulmonary fibrosis resulting from the inhalation of organic dusts have appeared in the literature. Always when such fibrosis is associated with the breathing of air containing organic dust, either inorganic dust has been shown to be present or at least its absence not definitely proved.

In regard to the presence of other irritating dusts, Chapman (20), Kessler (21), MacDonald (22), Kilgore (23), and others have reported cases of so-called acute silicosis, resulting from the inhalation of air containing high concentrations of silica along with strong alkali in a finely powdered form. Some have suggested that the rapid action of the silica in the production of pulmonary fibrosis is aided by the presence of these alkalis, because silica is more soluble in alkaline solutions. Kettle (24) failed to demonstrate such actions experimentally and states that proof is still lacking that any action of the kind may occur. Pathologic reports furnish evidence of a definite fibrosis, but the entire picture differs remarkably from that of the typical silicotic, such as has been furnished by Gardner (25) in his reports upon the examination of tissues from clinical cases of silicosis as well as his pathologic reports made from tissues obtained in his experimental studies. There is need of scientific

silica exists in nature is the amorphous hydrated form known as opal ($\text{SiO}_2 \cdot \text{H}_2\text{O}$). Opal, which is a silica of colloidal origin and occurs abundantly in the diatomaceous earths, is less resistant to reagents than quartz. Another type of free silica frequently found is flint, and with flint is found chalcedony, a waxy translucent form of silica interpreted as consisting of fibers of quartz with a small amount of interstitial opal. Other forms of free silica occurring less abundantly in nature are tridymite, cristobalite, and siliceous glass or vitreous silica.

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cupational analysis, it was found possible in a recent study to prophesy approximately in nine cases out of ten the conditions that would be found upon physical examination in cases in which the total changes were due chiefly to dust inhalation

TABLE 1 —DUST EXPOSURE OF MOLDERS

Activity	Time of Exposure in Minutes (a)	Av Dust Exposure in Millions of Particles per cu ft (b)	Millions of Particle-minutes (a × b)
Use of parting compound	54	63.8	3,445
Remaining task in molding	412	4.1	1,813
Pouring	55	3.1	180
Dumping molds (shake out)	16	32.5	620
Total	540		6,058

$\frac{6,058 \text{ million particle minutes}}{540} = 11 \text{ million particles per cubic foot}$

Predisposing Causes — The question of predisposing factors relating to the cause of silicosis has been given as much attention as the exciting cause. The part played by race may be disposed of very briefly by saying that it has not been scientifically proved that race itself exerts any influence either upon the production or the retardation of pulmonary fibrosis due to silica. Evidence of the harmful action of silica upon the lung tissues has been demonstrated in every part of the civilized world. From the same line of reasoning, climate, temperature, and related factors may safely be assumed to play no important rôle in the production of silicosis. It is obvious that sex can play no part in a disease of this nature except that the type of industries wherein the silica hazard is found employs relatively few women.

The relationship of age *per se* has not been demonstrated to be of great importance. While certain observers have reported that men past the middle ages may develop silicosis following shorter exposures than younger individuals, the element of infection has not been completely ruled out in such cases. Since respiratory infection has been shown to be the greatest pre-

disposing and complicating factor in the development of silicosis, certainly the history of present and past respiratory infections will have to be given consideration in the statistical analysis of records upon which such conclusions are based.

The factor of individual susceptibility is often mentioned. Generally speaking, if there be any difference in individual susceptibility, it can usually be considered an acquired and not a congenital condition, in this respect it may qualify along with age as a predisposing factor. We may have no clinical or experimental proof, but theoretically, at least, we would expect cardiac abnormalities to reduce the vital capacity of persons manifesting such a condition. Ickert (26) has furnished us a review of the question of personal susceptibility. He quotes Bohme, Lucanus, and Schulte-Tiggs as stating that it is essential for the individual to possess excellent functioning nasal passageways, in order that the self-cleansing mechanism may work efficiently. He calls attention to the fact that Irvine, Simpson, and Strachau report the "classical" type of silicosis to be more common among the robust type of individuals, while the "infective" type is more often observed among the phthisical individuals with less respiratory reserve. Ickert found some slight variation in the susceptibility of persons according to their type of body build. As a whole, the group classed as slender individuals developed simple silicosis somewhat more slowly than the stoutly built persons, but the incidence of advanced silicosis was greater in the former class, being nearly double that developing in the sturdy workers.

Lehmann's (27) experiments to determine the functional efficiency of the upper respiratory tract, in the removal of dust, suggests that abnormalities of the nasal passageways probably play some part in the rapidity with which silicosis may develop. Using dust with a high silica percentage, he found that from 83 to 73.7 per cent of the dust was retained during passage of air through the nose. In carrying out this experiment upon 62 miners,

cluding certain factors considered as predisposing, depends upon the dosage of free silica. This dosage is obviously dependent upon the amount of dust inhaled, the duration of exposure, and the frequency of intermittent employment as an aid in lessening the amount of changes produced, but aside from the fact that it does delay the reac-

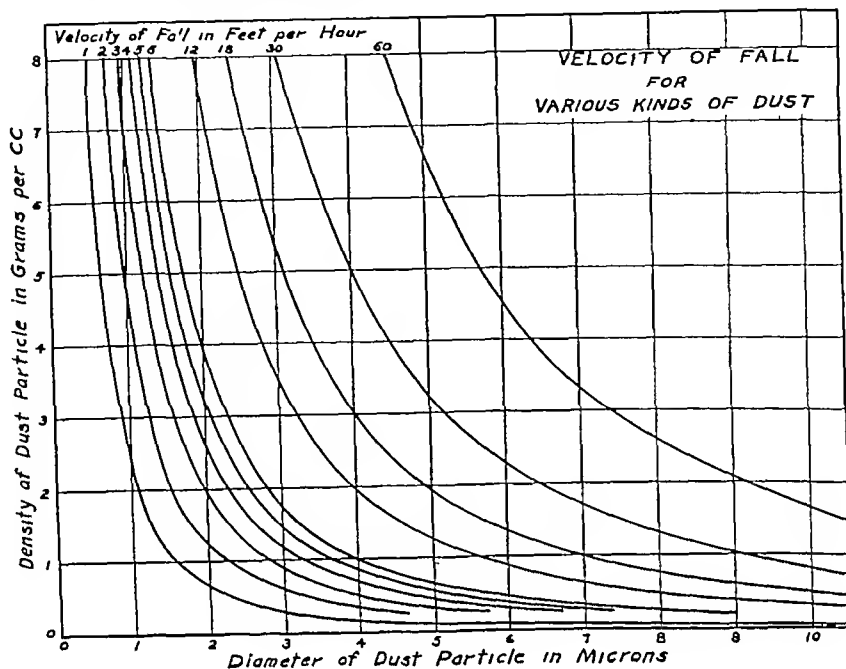


Fig 1

upon the amount of silica in the air inhaled, and the duration of exposure

In 1902, a committee, of which Dr J S Haldane was a member (13), reported upon an investigation made to determine the cause of excessive mortality rates from tuberculosis among the Cornish tin miners. This group decided it was evident that the inhalation of stone dust by these men in the performance of their tasks as miners, was the cause of permanent damage produced upon the lungs. Furthermore, they noted that the condition developed gradually in the case of the ordinary miner, but rapidly in the case of the machine workers who were exposed to greater amounts of dust. Dr Watkins-Pitchford (14), Dr Mavrogordato (15), and other South African workers, in their discussions relating to the etiology of silicosis, emphasize the relationship of the concentration of dust and duration of exposure to the degree of lung changes produced. Mavrogordato has suggested the advisability of inter-

tions, it has not been shown that it could safely be relied on to prevent silicosis, in cases in which exposure is to sufficient concentrations. It is intimated that the rest interval allowed by intermittent employment permits the lung to free itself of some of the particles. This avenue of elimination will vary with the types of dust, for example, limestone and coal dust are more readily eliminated than those concentrations with high percentages of free silica. Once the dust is taken up by the cell, the direction of the dust cell in its expulsion from the immediate site of action is toward the lymphatics as well as toward the epithelial lining of the bronchioles, and some portion will be retained. It is admitted that this rest interval will permit the subsidence of the irritative reaction, which no doubt accompanies the inhalation of foreign particles into the finer lung passages. Workers in this country have also shown the relationship of dosage to the severity of the reaction. Reports of the

TABLE VI—STANDARDIZED MORTALITY FROM RESPIRATORY TUBERCULOSIS IN OCCUPATIONS WITH RATES ABOVE AVERAGE (Males aged 20 to 65 years from 1921 to 1923 England and Wales)

Occupation	Mortality Rate (standardized)
All occupied and retired males	149.6
Tin and copper mines, underground workers not superintending staff (III)	1886.0
Tin and copper mines not superintending staff (III)	1323.5
Grinders in the cutlery tools (IV)	1178.5
Metal grinders (IV)	636.7
Slate masons and slate workers (III)	512.5
Potters' mill workers slip makers potters (III)	411.4

1915 to 1926, that the actual mortality from respiratory tuberculosis among the silica-exposed persons was about three times that of a non-silica exposed group. When this comparison is limited to the rates for some of the occupations with a very great silica exposure, such as metal mining, sandstone and granite quarries, the excess is still more striking, the rate being about ten times that obtained in the non-silica exposed group.

The initial studies of silicosis by workers in South Africa were started by a demand made upon the health authorities to determine the cause of the excessive mortality from tuberculosis which was increasing at a rapid rate among the gold miners there. The study by Russell and others (17) of the health of the granite workers was prompted in part by the excessive number of deaths reported as due to tuberculosis in the section of Vermont in which the granite industry is located.

Gardner's (33) statement that "At least 75 per cent of those human beings who develop silicosis die of tuberculosis, which may make its appearance at any stage of the disease," stresses the importance of the silicosis problem from the viewpoint of anti-tuberculosis activities. Rist and Donbron (34) advance the theory that there is no nodular fibrosis until the element of infection has entered the picture. Such a theory, however, does not agree with experimental work, which has shown that

the nodules may be produced in the absence of evidence of infection.

Kettle (35), Price (36), and others have shown that the tubercle bacillus will grow more rapidly upon culture media to which a small amount of silica offers a favorable medium for the growth of the organism. Gardner (37) has shown that animals exposed to silica, when inoculated with a strain of tubercle bacilli of low virulence will develop systemic tuberculosis and die, while control animals not so exposed usually are not seriously affected by injections of such organisms.

Progressive Tendency of the Disease—Since infection has been shown to play so important a rôle in the advanced stages of the disease, the possible relationship of this infective element to the progressive tendency of the disease cannot be overlooked.

Irvine (38) has stated that it is not so much what the condition of the silicotic is to day, as what it will become to-morrow. He emphasizes the tendency of the fibrosis to progress even though removed from exposure, and expresses his opinion that it is one of the most serious aspects of the whole silicosis problem. No remedy has been shown to be of value in elimination of the pulmonary fibrosis, although certain improvement in symptoms may be noted after the victim is removed from exposure. According to the observations made by Bohme-Bochum (39), silicosis progressed, after removal from exposure, in 20 per cent of the cases diagnosed as having silicosis Grade I, in 40 per cent of the cases in Grade II, and in practically all cases in Grade III. The course of silicosis among workers no longer exposed to silica dust is adequately stressed in the report of Russell (17), and the references discussed furnish evidence that regardless of termination of exposure, silicotics may eventually progress to a more severe and even fatal condition. Such reports from workers most familiar with the condition surely serve to emphasize the seriousness of this occupational disease.

In concluding, it may be stated that, to understand fully the true etiologic factors

research to determine the action of such concentrations of silica alone, as well as the reaction resulting from the inhalation of the alkali in the absence of silica, before the whole truth in regard to these cases will be known

Sayers, Meriwether, and Lanza (16) reported that, of the employees in the lead and zinc mines, those who gave a history of previous coal mining experience developed a definite silicosis in a shorter time than did employees of the same age without this experience. This cannot be taken to mean, however, that the inhalation of coal dust hastened the action of silica, for it is doubtful if any of these coal miners had worked where they were not exposed to some free silica, so the total dosage of silica was not the same in the two groups.

Occupational History—A discussion of the total dust exposure and its etiologic significance calls for a few words concerning the occupational history. Table III

TABLE III—OCCUPATIONAL RECORD

Date	Aug 8 1933	Office	Industrial hygiene
Name	K M	Present age	59
Age began work	15	No years worked	41
	Specific occupation	Specific industry	No years in hard non-dusty coal
Present	Section foreman	Anthracite coal	5
Preceding			
Present			
1	Contract miner (chamber)	Anthracite coal	15
2	Miners laborer (chamber)	Anthracite coal	3
3	Mule driver (dry mine)	Anthracite coal	3
4	Patcher (dry mine)	Anthracite coal	2
5	Slate picker (dry breaker)	Anthracite coal	2
6	Farm laborer (Pa)	Agriculture	1
Remarks	Estimates total time idle during working life 3 years		

shows how important it is to secure a complete occupational history and suggests a method of recording the same. Were we to examine an individual who states that he is foreman, and try to fit his dust exposure while at such work into the

picture found representing clinically and radiographically that of advanced silicosis, we would be led to think that such mild exposure was harmful, while the complete occupational exposure shows that his true dosage of silica has been very high. Furthermore, by recording complete data, we are able to express his average exposure in terms that may be compared to other cases of similar severity. Again, complete histories sometimes contain suggestive evidence of the true nature of the individual's disability. Especially is this so in those cases in which the worker has been continually changing to jobs requiring less and less physical effort. Table IV shows the

TABLE IV—ESTIMATION OF THE INDIVIDUAL'S TOTAL DUST EXPOSURE

Occupation	No Years	Dust Concentration in Millions of particles per Cubic Foot (Average)	Millions of particle-years per Cubic Foot
Slate pickers (dry mine)	2	380	760
Patcher (dry mine)	2	71	142
Mule driver (dry mine)	3	71	213
Miners' laborer (chamber)	3	480	1 440
Contract miner (chamber)	15	480	7 200
Section foreman	5	7	35
Total	30		9 790
9 790 millions of particle-years per cubic ft =			
30			
326 millions of particle-years per cubic ft			

method of analysis used to determine an estimate of the individual's total dust exposure.

More detailed application of our knowledge of the true cause of silicosis is illustrated in Table V. In this study of the actual duties required by the job, it is revealed that the greatest hazard is that in connection with the use of a parting compound. It is obvious that the risk associated with the work the man must do can be materially lessened by either using a parting compound containing less silica, or in properly safeguarding the user by adequate dust control during this operation. With such occupational histories available, and the knowledge of the percentage of total dust exposure revealed by detailed oc-

by Various Dusts and Their Influence on Tuberculosis
 Jour Path and Bact, May, 1932 35, 395-405

(36) PRICE R M Effects of Silica on the Growth
 of Tubercle Bacilli Canad Med Jour Research, 1932
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(37) GARDNER, LEROY U Tuberculous Infection
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 moconiosis Tubercle April 1925, 6, 336-341

(38) IRVINE, L G Chairman's Speech Opening
 of International Conference on Silicosis Johannes-
 burg, South Africa, 1930

(39) BOHME BOCHUM A The Prognosis of Silicosis
 Beitr z Klin d Tuberk, December, 1933, 84. (Re-
 viewed in Jour Indust Hyg Abstract Section May,
 1934)

he found that the average retention by the nose in the case of non-silicotics was about 50 per cent, while in the case of miners with silicosis, the average retention was only about 22 per cent

Chronic bronchial asthma may be considered a predisposing factor affecting individual susceptibility. The spasmodic attacks, if at all frequent, necessarily lead to a reduction in the individual's vital capacity. Aside from the pulmonary fibrosis, other pathologic manifestations of silicosis such as bronchiectasis, emphysema, and right-heart hypertrophy and dilatation, may be aggravated by this chronic condition.

Chronic infections of a local or constitutional nature may be shown to influence materially the incidence of silicosis.

As regards infection in general, Dr Lanza (28) has stated that in all his experience he can recall seeing but one patient who died of pulmonary fibrosis uncomplicated. The results of the survey in the Tri-State district emphasized the rôle played by infections in disabling silicosis, and mentioned the frequent occurrence of bronchial spirochetosis. Recently, Proske (29) has published reports of additional work along this same line, which should do much to stimulate the taking of preventive measures to control such infections in the sinuses and dental regions, as may serve as a source of these organisms.

Infections developing along the respiratory tract, whether confined to the upper air passageways or involving the bronchi and finer divisions of the lung, are of utmost importance. Sinus infections may act by decreasing the efficiency of the upper respiratory tract in the removal of dust from the air passing to the lungs, and also they may be the source of infections that spread to the lower respiratory tract. Acute pneumonic conditions as well as the more chronic lung changes, such as chronic bronchitis, bronchiectasis and bronchiolectasis, emphysema, and pleurisy, all tend to decrease the ability of the lung to rid itself of foreign materials through lessened lymphatic drainage and decreased power to

force the bronchial secretions and foreign matter from the lungs. When we consider the pathologic changes present in the lungs of individuals suffering from well established or advanced silicosis, we can understand how impossible it would be for such changes to exist for long without the factor of infection becoming evident. The dilated bronchi and areas of emphysema developing in persons as a result of abnormal demands made upon the lungs by glass blowers, divers, professional singers, trumpeters, and the like, seldom advance to the point at which the individual offers any complaint until infection has entered the picture.

Dr Christie (30), in a recent review and discussion of the subject of bronchiectasis, emphasized the infective element as well as other pathologic changes associated with the condition. The lung changes accompanying silicosis might be expected to lead to conditions favoring bacterial invasion. Some writers, who are most familiar with the problem, believe that the dense areas of fibrosis seen at autopsy or appearing as conglomerate shadows in the x-ray film possibly are dependent upon an infective process, either present before the absorption of silica or developing in an area of pulmonary fibrosis due to the action of the silica.

Tuberculosis and Silicosis—In 1905, Dr Summons (31), of the Miners' Phthisis Committee of Australia, reported that gold miners there who contracted silicosis died of tuberculosis. The increased incidence of tuberculosis among occupational groups exposed to silica has been clearly shown in every instance in which this hazard exists. Britten (32) summarized the report of the Registrar-General of England and Wales from 1921 to 1923, and showed the occupational mortality rate for the group of trades classed as "Dusty Trades" to be from three to more than ten times as high as the rate for all occupied and retired males (Table VI).

Lanza and Vane (7) show, by an analysis of the mortality experience of twelve life insurance companies, for the period of

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accounting for the development of silicosis in a single instance, requires detailed knowledge of the individual's occupational exposure past and present, together with facts obtained through a complete physical examination. Particular attention must be given to positive evidence of old or recent respiratory infection. Although slight mention may be made of the predisposing cause, after all, in the great majority of cases, whether individuals will develop silicosis depends almost entirely upon the concentration of free silica particles under 10 microns in diameter to which they may be exposed and the duration of such exposure.

REFERENCES

- (1) COLLIS, EDGAR L. Industrial Pneumoconoses with Special Reference to Dust Phthisis. Milroy Lectures, 1915
- (2) ROVIDA L. Un caso di silicosi del polmone con analisi chimica. Ann di chim appl a med 1871 53, 3
- (3) Committee on Pneumoconiosis and Committee on Standards. Report of Am Public Health Assn Annual Meeting November 1932
- (4) KNOPF ADOLPH. Description of Silica. Public Health Bulletin No 187. The Health of Workers in Dusty Trades II Exposure to Siliceous Dust (Granite Industry) 1929
- (5) LADOO, R B. Non metallic Minerals. Occurrence, Preparation Utilization. McGraw-Hill Book Co., New York, 1925
- (6) BLOOMFIELD J J, JOHNSON W SCOTT, and SAYERS R R. Potential Problems of Industrial Hygiene in a Typical Industrial Area. Public Health Bulletin, 216, December, 1934
- (7) LANZA, A J and VANE, ROBERT J. The Prevalence of Silicosis in the General Population and its Effect upon the Incidence of Tuberculosis. Am Rev Tuberc., January, 1934.
- (8) GARDNER, LEROY U. Studies on Experimental Pneumoconiosis, Reactivation of Healing Tubercles in Lung by Inhalation of Quartz Granite and Carborundum Dusts. Am Rev Tuberc December, 1929 20, 833-875
- (9) COLLIS EDGAR L and GREENWOOD MAJOR. Health of the Industrial Worker. P. Blakiston's Son and Company, 1921
- (10) GYE, W E and KETTLE E H. Silicosis and Miners' Phthisis. British Jour Exper Path 1922 3, 241
- (11) MILLER JOHN W, and SAYERS R R. The Physiological Response of Peritoneal Tissue to Dusts Introduced as Foreign Bodies. Public Health Reports Jan 19, 1934, 49, No 3
- (12) SAYERS R R. Experimental Studies on the Effects of Ethyl Gasoline and its Combustion Products. U S Bureau of Mines Monograph No 2, 1927
- (13) HALDANE, J S, MARTIN J S and THOMAS R A. Report to the Secretary of State for the Home Department on the Health of Cornish Miners. Cd 2091, H M Station Off London, 1904
- (14) WATKINS-PITCHFORD, W. Miners' Phthisis Its Cause, Nature, Incidence, and Prevention. Pan-Pacific Sc Congr, Melbourne, 1923. Med Jour Australia, Oct 13, 1923
- (15) MAVROGORDATO, A. Etiology of Silicosis. In International Conference on Silicosis. Johannesburg, South Africa, 1930
- (16) SAYERS, R R, MERIWETHER, F V, LANZA, A J, and ADAMS W W. Silicosis and Tuberculosis among Miners of the Tri-State District of Oklahoma, Kansas and Missouri. U S Bureau of Mines of the Department of Commerce Technical paper 545, 1928
- (17) RUSSELL, A E, BRITTEN R H, THOMPSON L R and BLOOMFIELD, J J. The Health of Workers in Dusty Trades II Exposure to Siliceous Dust (Granite Industry). Public Health Bulletin 187, July 1929
- (18) BLOOMFIELD, J J, and DREESSEN, W C. Silicosis among Granite Quarriers. Public Health Reports June 8 1934, 49, No 23
- (19) THOMPSON, L R, BRUNDAGE, DEAN K, RUSSELL, A E, and BLOOMFIELD, J J. The Health of Workers in Dusty Trades I Health of Workers in a Portland Cement Plant. Public Health Bulletin 176 April, 1928
- (20) CHAPMAN E M. Acute Silicosis. Jour Am Med Assn, April, 1932 98, 1439
- (21) KESSLER W H. Silicosis in the Abrasive Powder Industry. Jour Am Public Health Assn, December 1931
- (22) MACDONALD G, PIGGOT A P and GILDER F W. Two Cases of Acute Silicosis. Lancet October 1930, 2, 836
- (23) KILGORE, E S. Pneumoconiosis, Unusually Acute Form. Jour Am Med Assn, Oct 22 1932 99, 1414
- (24) KETTLE, E H. The Action of Harmful Dusts. Proc Forty-third Session 1933-1934. The Institution of Mining and Metallurgy, London, 1934
- (25) GARDNER, LEROY U. Pathological Study of Eight Lungs from Employees in the Granite Cutting Industry. Public Health Bulletin 187 1929
- (26) ICKERT, FRANZ. Staublunge und Tuberculose. Ergebn d ges Tuberk, 3, 433
- (27) LEHMANN, G. The Function of the Nose as a Dust Filter. Arbeitsphysiol, 1933 7, 167
- (28) LANZA, A J. Etiology of Silicosis. Jour Am Med Assn, Aug 19 1933 101
- (29) PROSKE H O. Pulmonary Infection in Pneumoconiosis I A Bacteriologic and Experimental Study. Public Health Reports, July 20, 1934, 49, No 29 II Fuso-spirochaetal Infection. Experiments in Guinea Pigs. Public Health Reports Oct 12 1934 49, No 41
- (30) CHRISTIE, A C. Bronchiectasis Its Diagnosis and Treatment. Paper Presented at the Interstate Post graduate Assembly Cleveland, Oct 17 1933
- (31) SUMMONS W E. Report of Miners' Phthisis Submitted by the Committee of the Bendigo Hospital Victoria 1907
- (32) BRITTEN, R H. Occupational Mortality among Males in England and Wales, 1921, 1923. Summary of Report of Registrar-General. Public Health Reports June 1928 43, No 46
- (33) GARDNER LEROY U. Silicosis and its Relation to Tuberculosis. Am Rev Tuberc, January, 1934
- (34) RIST E and DOYBRON S. Silicosis and Tuberculosis. Med du Travail 1934 6, 39-62
- (35) KETTLE E H. Interstitial Reactions Caused



Fig. 2 The thickness of the left ventricle is measured by a perpendicular from the point of greatest salience of the left ventricle (arrow) to a line joining the apex and auriculo-ventricular sulcus

it ends by anastomosing with the circumflex branch of the left coronary. The left coronary artery arises from the posterior aortic sinus and runs between the root of the pulmonary artery and the left auricle to the coronary sulcus at the upper end of the interventricular groove, where it divides into two branches: an anterior descending branch, which runs down the interventricular sulcus to the apex supplying both ventricles; a posterior circumflex branch, which turns round the left margin of the heart and continues to its inferior surface, where it ends by anastomosing with the terminal arborizations of the right coronary. The circumflex branch supplies the left margin of the heart and the posterior part of the inferior surface of the left ventricle.

The left coronary artery is much more commonly involved than the right (5, 6, 7, 8, 9, 10, 11). Interesting anatomical evidence has been produced by Whitten (10) and Boyd (5), who have both shown that

thrombosis of the anterior descending branch most commonly involves the apex and the lower half of the anterior surface of the left ventricle, the anterior part of the interventricular septum and the papillary muscles of the left ventricle.

The circumflex branch ranks second in incidence as the site of thrombosis. It involves the obtuse margin of the left ventricle, half way from base to apex, but sometimes also the base and the apex. These changes are shown topographically in Figure 1. It becomes apparent that the vessels most commonly thrombosed involve that portion of the heart which contributes to the formation of its left border as seen in the roentgenogram.

It has been shown (12, 13, 14) that the thickness of the left ventricular myocardium can readily be determined from the roentgenogram of the heart (Fig. 2). A line is drawn connecting the apex of the heart with the auriculo-ventricular junction on the left. To this is erected a perpendicular from the point of greatest salience of the left ventricular contour. This perpendicular (bisector) is a close approximation to the thickness of the wall of the left ventricle and normally measures from 8 to 10 millimeters.

The thickness of the left ventricle as measured by its bisector is produced by two factors: first, the actual amount of heart muscle present; second, the tone of that muscle. Other factors being equal, if the tone of the myocardium is increased, there is a shortening and thickening of the muscle fibers; if there is a diminution of tone, there is a lengthening and relaxation of muscle fibers reducing the thickness of the myocardium.

Coronary disease is insidious in its onset. There is at first an endarteritis involving the intima. Later the middle and external coats become involved. Thus there is a gradual occlusion of the vessel, resulting in a diminished blood supply to the area of distribution of the involved vessel. The degree of occlusion may be variable. If the degree of thrombosis is complete, an anemic infarct is produced, over which the surface

FURTHER OBSERVATIONS ON THE ROENTGEN DIAGNOSIS OF CORONARY DISEASE¹

By GEORGE LEVENE, M D , *Boston, Massachusetts*

ACCORDING to statistics taken from some of the large life insurance companies, coronary disease is one of the most common causes of death. Moreover, the incidence of death from coronary disease shows a progressive and actual rise

clinical, and necropsy investigations by a large number of observers. Since then, experience gained in the study of numerous additional cases together with confirmatory observations in other clinics have strengthened the reliability of the signs and

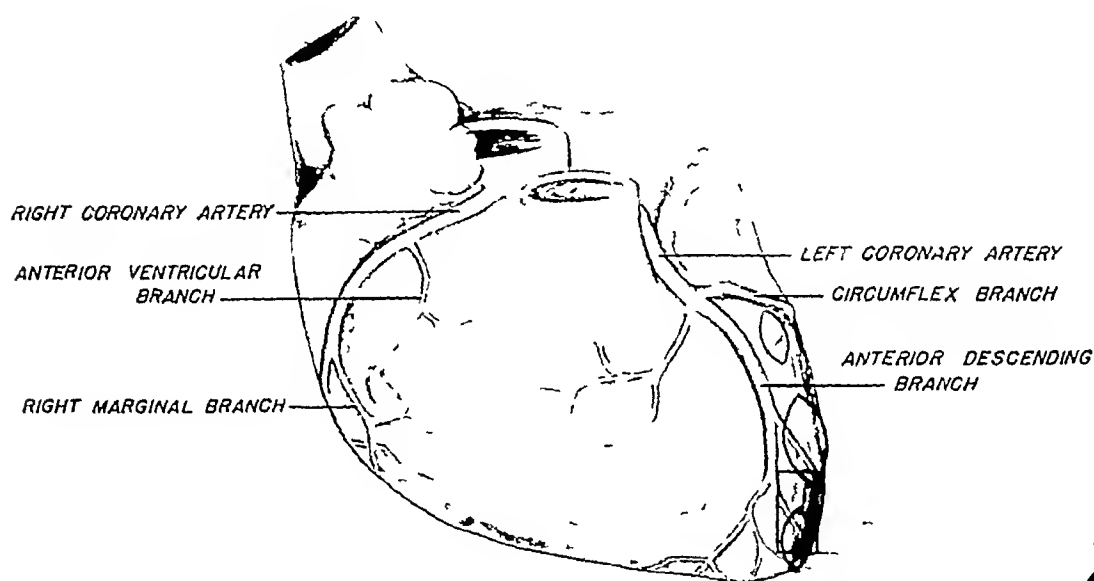


Fig 1 The coronary arteries (after Cunningham) showing most common sites of infarction. The rectangle represents thrombosis of the anterior descending branch, the ellipses represent the circumflex branch.

For example, among the industrial policy holders of the Metropolitan Life Insurance Company, deaths from coronary disease increased 200 per cent in 1933 as compared with 1930 (1, 2). It is, therefore, obvious that every diagnostic aid must be invoked for the earlier recognition of this very common and serious affliction.

In a previous communication (3) on the roentgenologic signs of coronary disease we described diagnostic criteria based upon known physiologic and pathologic changes accruing from a multiplicity of laboratory,

yielded additional information useful in the roentgenologic diagnosis and observation of coronary disease.

ANATOMICAL AND PATHOLOGICAL CONSIDERATIONS

The coronary arteries (4) arise from the aorta—the right from the anterior aortic sinus and the left from the posterior aortic sinus (Fig 1). The right coronary artery runs between the root of the pulmonary artery and the right auricle to the coronary sulcus, in which it passes to the right, giving off an anterior ventricular branch, then, turning round the right border of the heart, is continued on its posterior surface, where

¹Presented before the Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

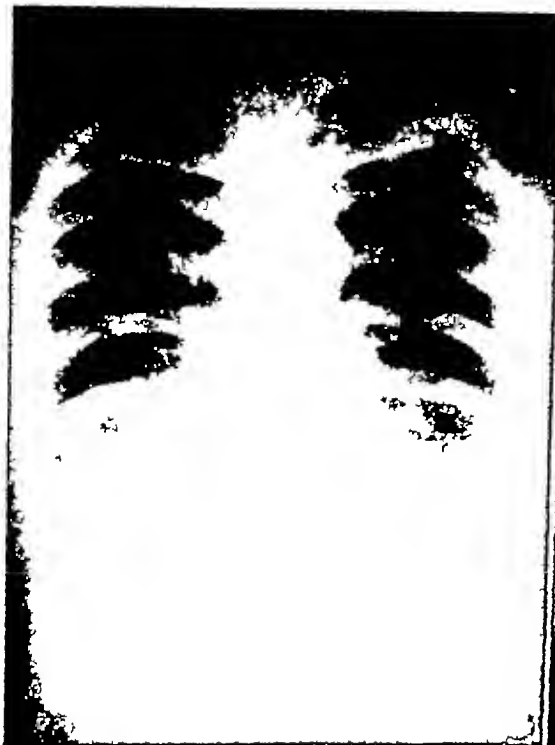


Fig 5 Coronary thrombosis showing the typical loss of convexity of the left border. Roentgenoscopically there is a localized diminution in the amplitude of ventricular contractions.



Fig 6 Coronary thrombosis. The heart appears to 'sag'. The amplitude of ventricular contractions is greatly diminished.

the cardio-vascular silhouette. Frequently, the change may be emphasized by examination during deep inspiration which not only permits of better visualization of the cardiac apex but accentuates the difference in intensity of beat of component elements of the cardio-vascular shadow. It is also frequently helpful to turn the patient a few degrees in the right and left anterior oblique positions. This brings into profile the right and left ventricles, respectively, and tends to eliminate a confusing factor of motion transmitted from the unaffected adjacent heart muscle. It may be predicated as axiomatic that a *localized diminution in the amplitude or force of left ventricular contractions is due to myocardial impairment*. Not all myocardial impairment, however, is due to coronary thrombosis. It is frequently necessary to exclude other causes of myocardial damage, such as rheumatic myocarditis, hypertensive failure, and depleting constitutional mala-

dies. While it has been our custom to make a roentgen cardiac diagnosis without previous knowledge of the history or physical findings in the case, it may frequently be necessary or expedient to render an opinion after clinical consultation.

Roentgenograms usually show typical alteration in the contour of the heart (Fig 5). This consists of a loss of convexity of the left border. The left border may become straight or concave. The degree and extent of change depend upon several factors: the acuteness and severity of infarction, the condition of the myocardium prior to the accident, and the degree of broken compensation resulting from thrombosis (Figs 6, 7).

There is a common misconception even among cardiologists, that the heart is always enlarged in coronary thrombosis. This is not true. While such a change does occur, it is not necessarily present. We have examined cases of coronary throm-



Fig 3 Coronary thrombosis, with infarction in the wall of the left ventricle (sectioned) Note flattening of the left ventricular myocardium in the region included in brackets



Fig 4 Cardiac aneurysm following coronary infarction Arrow points to aneurysm

of the myocardium is retracted (Fig 3) Subsequently this area undergoes fibrosis. Occasionally there may be absorption of the infarct, leaving the myocardium thin and bulging and predisposing to the formation of a cardiac aneurysm (Fig 4) Whitten (10) has shown that there is a marked thinning of the ventricular wall due to occlusion of a large vessel and that a localized depression on the surface of the heart is produced by occlusion of a small vessel coming off at right-angles.

As the blood supply to a portion of the heart muscle is shut off by occlusion of its main source, a collateral circulation is established which ultimately may carry on more or less effectually the task of supplying blood to the area formerly nourished by the thrombosed vessel.

ROENTGENOLOGIC SIGNS

The changes upon which roentgenologic diagnosis of coronary disease depends are

derived from careful roentgenoscopic study as well as examination of the film. A roentgenkymogram (15, 16) also records useful data, particularly if the course of the case under treatment is to be followed, but by far the most important element in diagnosis is careful roentgenoscopic examination.

On the screen we see a definite diminution in the amplitude and force of contraction in the region of the left ventricle. The diminished force may be observed over the entire border of the ventricle or it may be more pronounced in one portion of the left border. In appraising this change it is necessary to make careful comparison of the force of the beat of the involved area with the apex, the left auricle, the right border, and the aorta. In this manner, the degree of diminution of the left ventricular force is readily perceived, for, in the normal heart, the excursion of the left ventricular contractions is greater than in other regions of



Fig 9 Coronary sclerosis. There is no alteration in cardiac contour. There is a generalized but slight diminution in the amplitude of contractions.

occlusion, and the diminished amplitude is *not* pronounced in any particular segment of the cardiac silhouette—there is a general, moderate diminution.

CORONARY THROMBOSIS AND HYPERTENSION

The association of coronary thrombosis and hypertension is by no means uncommon. As a general rule, it is unusual to find coronary thrombosis in women who have not had hypertension. This does not hold true in men (17).

The effect of chronic hypertension is to produce definite alterations in the size, contour, and roentgenoscopic appearance of the heart. Because of the increased peripheral resistance there is dilatation of the left ventricle and hypertrophy of its wall (Fig 10). Roentgenoscopically one observes an increase in the amplitude of ventricular contractions, together with increased pulsations of the aorta. With the advent of coronary thrombosis and infar-



Fig 10 The heart in hypertension shows hypertrophy with variable dilatation of the left ventricle. Note its smooth, rounded contour. The curve of the ascending aorta is accentuated. Roentgenoscopically the amplitude of contractions is increased in the region of the ventricle and aorta.

tion in the wall of the ventricle, alterations of contour are produced (Fig 11). The left heart border shows a flattening at the site of the involved myocardium. Roentgenoscopically, the amplitude of contractions in this area is definitely diminished.

CORONARY THROMBOSIS AND CARDIAC ENLARGEMENT

Patients who have not had previous disease of the heart need not necessarily show cardiac enlargement with thrombosis. We have seen clinicians doubt the existence of coronary thrombosis, even in the presence of almost every classical sign and symptom, merely because the heart was not enlarged. This misconception not only militates against early diagnosis but detracts from the importance of cardiac enlargement as a prognostic sign when it is present.

Let us assume that the patient has had no previous heart disease and that he de-



Fig 7 Coronary infarction with aneurysm (arrow) of left ventricle. The heart contour is typical of coronary disease.



Fig 8 Kymogram of heart in coronary thrombosis. Note the marked diminution in the amplitude of ventricular contractions in area included in brackets.

bosis, even in the acute stage, in which cardiac enlargement could not be demonstrated by any known method.

Bearing in mind the pathologic physiology of coronary disease, the roentgenologic changes are readily understood. The loss of convexity or sagging of the left border results first, from a loss of tone, and second, from an actual destruction of muscle fibers. The thickness of the left ventricle as measured by its bisector is reduced and the left and right median diameters lie close to the diaphragm.

A roentgen kymogram of the heart will show a localized diminution in the amplitude of ventricular contractions (Fig 8). It must be remembered, however, that the usual horizontal slit kymogram records only lateral excursion of the heart and that the vertical component of motion is not registered. It is therefore unwise to attempt a diagnosis of coronary disease without roentgenoscopic examination. Per-

haps the principal usefulness of the kymogram is to record what is observed on the screen and to afford a better basis for comparison of subsequent examinations of the case under treatment.

CORONARY SCLEROSIS

Gradual narrowing of one or more coronary arteries with atheromatous degeneration may be a local manifestation of a generalized vascular sclerosis. In such cases there may be visible evidence of sclerosis in the thoracic or abdominal aorta, the internal iliac, or peripheral arteries. Here one does not observe changes of so marked a degree as in coronary thrombosis (Fig 9). There may be little, if any, change in the contour of the heart. As a rule, the heart will probably be small unless there is an associated hypertension. Roentgenoscopically, the amplitude of ventricular contractions is diminished, but not to such a degree as is found in complete

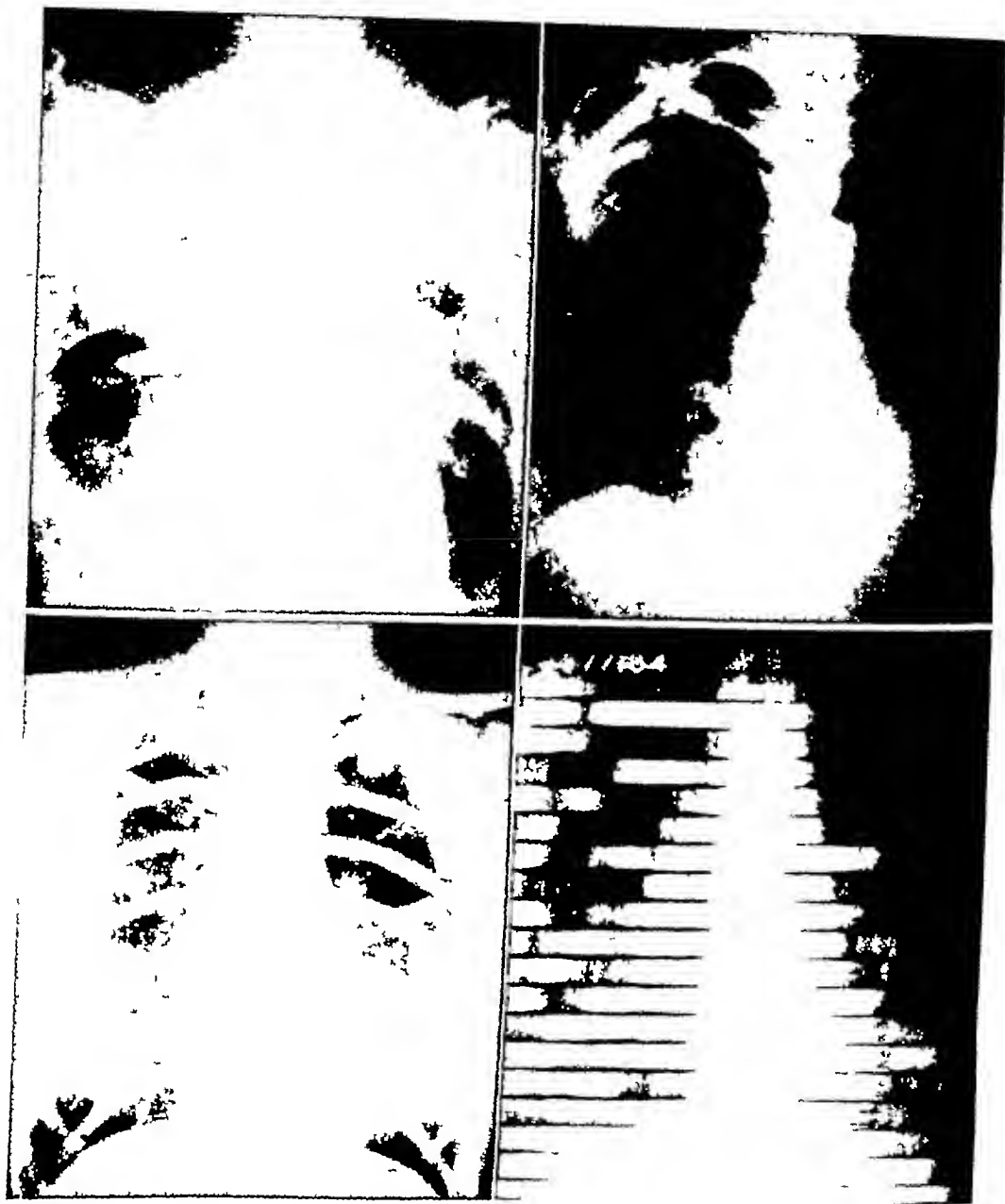


Fig 15 (*upper left*) Aortic insufficiency may be a cause of anginal attacks. Note the marked increase in the length of the heart due to dilatation of the left ventricle. Typical water hammer pulsations are observed roentgenoscopically.

Fig 16 (*upper right*) Aortic stenosis. Note the marked hypertrophy of the left ventricle. Ventricular contractions are slow and vigorous, while the amplitude of aortic pulsations is diminished.

Fig 17 (*lower left*) The heart in thyrotoxicosis shows a loss of convexity of the left border which sometimes simulates the appearance of coronary disease. However, there is usually an increased prominence of the pulmonary artery and the amplitude of pulsations is greatly increased (see Fig 18).

Fig 18 (*lower right*) Kymogram of the heart in thyrotoxicosis (same case as Figure 17). The type of pulsations is distinctive.

shut off—and so it relaxes. As the left ventricle relaxes the mitral ring is stretched and a relative mitral insufficiency develops.

At this time, there is an increase in the transverse diameter of the heart and one can detect a systolic murmur at the apex—



Fig 7 Coronary infarction with aneurysm (arrow) of left ventricle. The heart contour is typical of coronary disease.



Fig 8 Kymogram of heart in coronary thrombosis. Note the marked diminution in the amplitude of ventricular contractions in area included in brackets.

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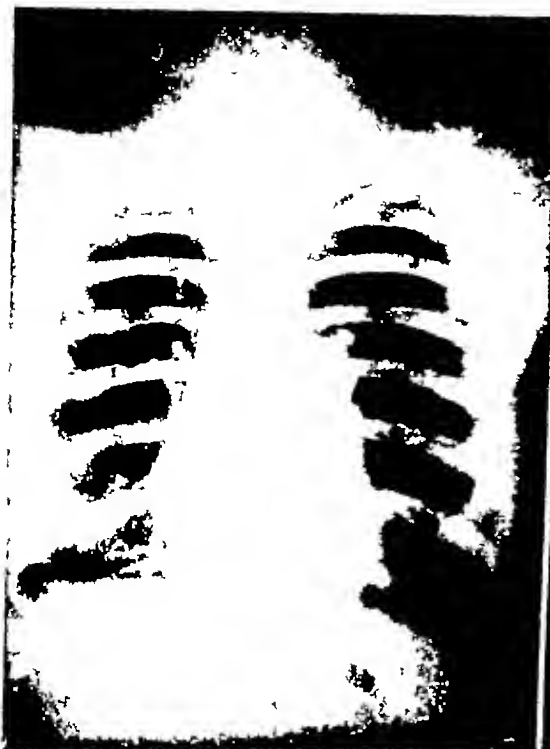


Fig 20 Angina pectoris shows no alteration of cardiac contour or size unless there is an associated cardiopathy

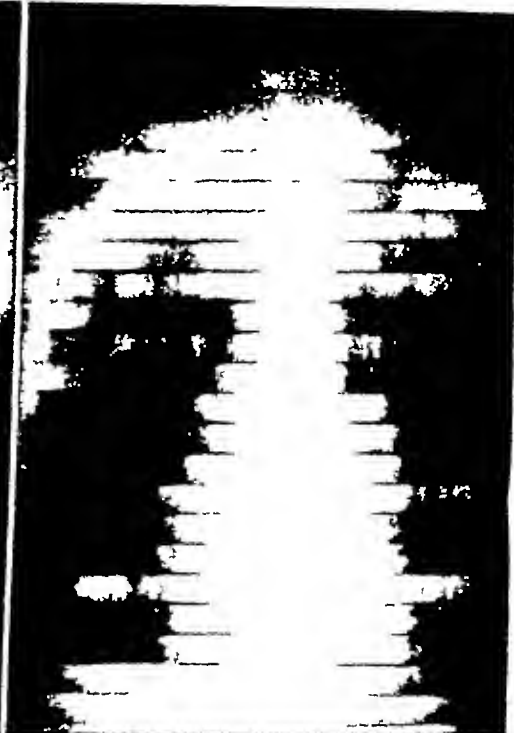


Fig 21 The amplitude of contractions in angina pectoris is not diminished; it may be increased (Same case as Figure 20)

increased prominence of the shadow of the pulmonary artery (Fig 17). At times, the appearance may be not unlike that observed in coronary thrombosis. In the former, however, there is an accelerated rate with an increased amplitude of pulsations (Fig 18).

Anemias and chronic metabolic disorders almost always show moderate cardiac dilatation without hypertrophy (Fig 19). There is only slight, but general, diminution in the amplitude of contractions.

It might be well to emphasize that angina pectoris usually accompanies effort—frequently walking, eating or some other physical or emotional strain—so that generally speaking, pain in the chest which appears when the patient is at rest has another etiologic basis.

Unless there is an associated cardiopathy, the heart in angina pectoris shows no alteration in size or contour (Fig 20). Roentgenoscopically, the amplitude of pul-

sations is normal, or may even be increased (Fig 21). Diagnosis, therefore, resolves itself to the exclusion or identification of organic heart disease, in the absence of which the heart contour will appear normal, the presence of normal contractions, and the history. With the advent of coronary thrombosis the roentgenologic manifestations of the latter will be in evidence.

We shall not attempt to present, at this stage, a statistical analysis of our studies. While the series includes several hundred cases, in only a comparatively small number have we had the opportunity for necropsy. It is hoped that others will be stimulated to report their cases so that final proof of the value of roentgenologic diagnosis of coronary disease may be established. We have, nevertheless, been highly encouraged by the findings in those cases that have come to autopsy and by confirmation by other clinical methods and the progress of cases examined.

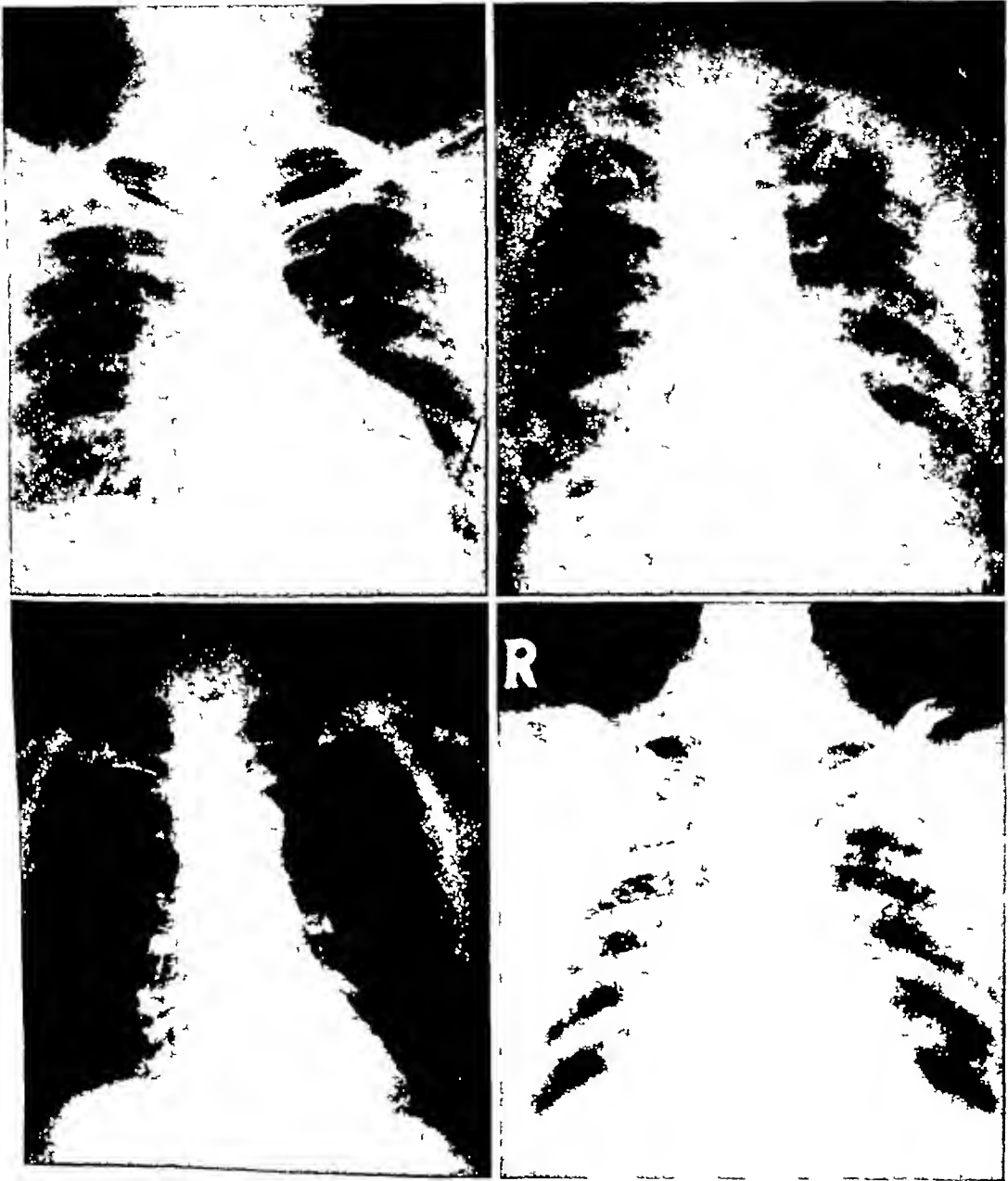


Fig 11 (*upper left*) Coronary thrombosis with infarction following hypertension. Note the marked flattening of the left ventricle (bracket) as compared with Figure 10. The flattened area showed a marked diminution in the amplitude of contractions.

Fig 12 (*upper right*) Coronary thrombosis showing typical loss of convexity of left border. The amplitude of ventricular contractions was decreased. Compare with Figure 13.

Fig 13 (*lower left*) Same case as Figure 12 one month later. Note partial restoration of contour due to recovery of tone. Note also that the heart as a whole was not enlarged.

Fig 14 (*lower right*) Coronary thrombosis with failure. There is a loss of convexity of the left border with an increase in the transverse diameter of the heart and congestive infiltration in the lungs. These changes indicate progressive myocardial weakening.

velops acute coronary thrombosis. In such a case there is a very sudden alteration of cardiac dynamics. The acutely embar-

assed heart-muscle is unprepared and unequal to the strain of contracting properly with an important avenue of blood supply

THE ABSORPTION OF ETHYLENE GAS FOLLOWING ENCEPHALOGRAPHY, WITH A CLINICAL CORRELATION IN 164 CASES

By ROBERT B. AIRD, M.D., *San Francisco, California*

From the Department of Surgery, University of California Medical School

THE roentgenographic follow-up in the study of encephalography with the use of ethylene gas (1, 2) has been of great interest. In certain patients the ethylene has disappeared at an unusually slow rate when compared with that at which the gas disappears in the great majority of cases. This report deals with the estimation of the rate of disappearance of the gas, the interpretation of this phenomenon, and its correlation with the clinical data, especially in those patients in whom the gas disappeared with unusual slowness.

Method—Single horizontal transverse projections with the occiput down, tube to the side, have proved to be the most valuable views in estimating the rate of disappearance of the gas from the ventricles and subarachnoid spaces following encephalography. This projection is most likely to show any gas that remains. It permits a demonstration of both lateral ventricles and the third ventricle in their long axes and, in addition, demonstrates to the best advantage subarachnoid gas in the basal cisterns and over the frontal cortex. From a series of such views, taken at successive periods following the injection, a roughly accurate estimate of the rate of disappearance of the gas may be made. Early in this study a series of follow-up views was taken in this manner after each encephalogram to establish as closely as possible the rate of disappearance of ethylene. Later, single projections taken three hours after the injection of the gas served to demonstrate whether the rate of disappearance was normal or delayed. If delayed, subsequent films were taken to follow more closely the rate of disappearance of the gas. In each case the estimate was based upon a comparison with the original transverse projection, the second view ordinarily taken in the encephalographic series (1). In this view

the filling was arbitrarily taken as 10 per cent, and the fillings in subsequent films were estimated on a percentage basis in reference to this original view. In this fashion repeated estimates of the same film have shown that this method is almost always accurate within 10 per cent and usually within 5 per cent. On such a percentage basis and within limits which will be considered later a comparison may be made between the relative rates of disappearance of ethylene following its encephalographic injection in different patients.

Interpretation—A study of the follow-up roentgenograms in 164 patients shows that in a large majority of cases the ethylene gas disappears within certain time limits and that in the remainder the rate of disappearance is slower. A curve representing the lower limits of what may be termed "normal" absorption was established on the basis of the most delayed estimates, in the numerous determinations made in this series, in which the patients were judged, from their encephalographic and clinical findings, to possess a "normal" circulation of cerebrospinal fluid (see Fig 1). Although individual curves of the rate of absorption of ethylene could not be determined on the basis of the few follow-up views that were obtained in those patients in whom the rate of disappearance seemed retarded, their gross deviation from the usual "normal" rate was nevertheless very obvious.

The establishment of the curve defining the lower limits of the "normal" rate of absorption of ethylene following encephalography was selected arbitrarily, of necessity, as were the criteria of "normal" circulation of cerebrospinal fluid. May it then be concluded that a delayed disappearance of the gas necessarily implies an abnormal condition—presumably a patho-

evidence of mitral insufficiency. However, if the process of occlusion is gradual, there is usually a more or less adequate collateral circulation and the heart does not relax so completely as to allow stretching of the mitral ring. There is no increase in transverse diameter of the heart and no murmur may be elicited at the apex. If this patient is kept under observation it may be found that there is functional recovery in three or four weeks and the patient may return to modified physical activity (Figs 12 and 13), or the x-ray may show an increase in the transverse diameter of the heart. This is evidence of a relative mitral insufficiency due to relaxation of the left ventricle and should be regarded as a sign of impending failure. The lungs will usually show congestive infiltration (Fig 14). If the patient is allowed unrestricted activity, serious sequelæ may be anticipated.

DIFFERENTIAL DIAGNOSIS

The symptom-complex of coronary thrombosis may be confused with other cardiac and non-cardiac conditions. Complete roentgenologic examination is at least as well suited to differentiate these as any other single means at our disposal.

It is a strange fact, perhaps common experience in large roentgenologic clinics, how frequently we discover coronary disease in patients who are referred for x-ray examination of the gastro-intestinal tract, the gall bladder, or, even, the left shoulder, because of symptoms referable to these areas and, frequently, coronary disease is the only cause of these symptoms. The roentgenologist who always explores the thorax in every gastro-intestinal examination is thus in position to detect previously unsuspected coronary disease.

ANGINA PECTORIS

While angina pectoris is related to coronary thrombosis the conditions are not identical. The latter signifies occlusion of the coronary arteries, the former is a clinical syndrome of pain, usually at the sternum, shortness of breath, and a sense of impending death. It is frequently possible



Fig 19 Anginal attacks may be observed in chronic blood dyscrasias. Frequently there is dilatation of the heart. The above is a case of severe macrocytic anemia. There is a slight, but general diminution in the amplitude of cardiac contractions.

to detect an etiologic factor in the production of angina pectoris in the form of diabetes, aortic valvular disease, hyperthyroidism, and chronic anemias. Some of the latter present typical roentgen findings which assist in their ready identification.

Aortic insufficiency (Fig 15) shows a dilated left ventricle so that there is always an increase in length and frequently in the transverse diameter of the heart. The aorta is usually widened. Roentgenoscopically, one observes the typical "water-hammer" pulse—a slow systolic movement of the ventricle and aorta, with a rapid diastolic movement in the opposite direction.

Aortic stenosis presents enlargement of the left ventricle consisting of dilatation of the chamber and considerable hypertrophy of its wall as shown by its bisector (Fig 16). Roentgenoscopically, one observes a slow, vigorous contraction of the left ventricle with diminished amplitude of aortic pulsations. In advanced cases, calcification of the aortic valve may be seen.

Thyrocardiac disease shows a loss of convexity of the left heart border, with an

degree of saturation of the solvent rises, it seems safe to conclude that the factors altering the formation, circulation, and absorption of cerebrospinal fluid are probably the most important in determining the variation in the rate of disappearance of the gas. Inasmuch as obstructions to the circulation and absorption of cerebrospinal fluid are commonly attended by clinical manifestations and varying degrees of hydrocephalus, the determination of this point is always of great importance. If the obstruction is considerable, the diagnosis is readily made on the basis of large ventricles accompanied by large subarachnoid spaces (communicating hydrocephalus) or obliterated subarachnoid spaces (adhesions) over the cerebral cortex. In such advanced cases, with associated clinical signs and symptoms of increased intracranial pressure, ventriculography is preferred to encephalography. In many cases, however, as will be shown, the diagnosis is not so clear. If, following encephalography in this group, observation on the rate of disappearance of the gas could be correlated with the formation, circulation, and absorption of the cerebrospinal fluid, such additional information might be of great value in corroborating or clarifying the usual static interpretation of encephalograms. Such a correlation as this would be possible only if the other factors concerned with the absorption of the gas could be shown to be negligible or relatively constant.

2 In certain cases an abnormally large amount of cerebrospinal fluid may be present in the ventricles and subarachnoid spaces. Consequently, the gas injected would bear a variable relationship in its ratio to the total fluid present and its absorption would be delayed for that reason. The exchange of gas and fluid, however, is measured and known in each case and, when considered in connection with the size of the ventricular and subarachnoid spaces, as demonstrated by x-ray, permits this group to be ruled out of consideration. Forty-four such cases occurred in the series

of 208 patients who were followed. One case will serve to illustrate this group. A boy, 19 years of age, with a convulsive state of traumatic origin, was found to have a porencephalic cyst and cerebral atrophy. Because of an asymmetrical subarachnoid filling, cortical adhesions had been suspected also. The absorption of gas in this case was apparently slightly delayed, but, because 275 c.c. had been injected, it was felt that the slow disappearance of the gas did not actually represent an abnormally slow rate of absorption of cerebrospinal fluid. (For further discussion, see under Results.) Other patients in whom small and inadequate encephalographic injections were obtained were not included in this series.

As a rough criterion for the normal encephalographic injections of ethylene, the average values found in 100 cases previously reported (2) may be mentioned:

Children up to six years	80 c.c.
Children from six to sixteen	100 c.c.
Adults (sixteen years and over)	136 c.c.
Large adults (maximum normal)	150 c.c.

3 Because of the viscosity and surface tension of fluids, a gas, following its encephalographic injection, tends to displace with difficulty the cerebrospinal fluid in the more narrow and tortuous channels of the supracortical subarachnoid spaces. This would be particularly true if these channels were abnormally constricted or partially blocked, as, for example, by cortical adhesions. Under such conditions the gas would be limited, for the most part, to the larger channels—the basal cisterns and ventricles. Because of this fact and also because the surface contact between fluid and gas would be more limited, the absorption of the gas would be retarded. Under ordinary conditions there is a fair margin of safety in the absorptive mechanism—in the extent of the absorptive bed and the size of the subarachnoid channels leading to it. Under the abnormal conditions considered, however, the margin of safety would be reduced and, correspondingly, the absorption of gas following encephalography would be retarded for the reasons already

SUMMARY AND CONCLUSIONS

Coronary disease is one of the most common causes of death. Roentgenologic study is an important additional means of diagnosis.

The typical case of coronary thrombosis shows an alteration in the contour and contractions of the heart. There is a loss of convexity of the left heart border, with diminished amplitude of pulsations in this area. The appearance of an increase in the size of the heart in coronary thrombosis is an indication of failure. Cases of chronic hypertension that develop coronary thrombosis show hypertrophy of the left ventricle, with an area of localized flattening. In this region the amplitude of contractions is definitely diminished.

Coronary sclerosis produces a moderate but general diminution in the amplitude of cardiac contractions, with no alteration of contour.

Angina pectoris presents no alteration in cardiac contour or size unless there is an associated cardiopathy. The amplitude of contractions is not impaired, but frequently is typical of the associated lesion.

BIBLIOGRAPHY

- (1) DUBLIN, L. I. and ARMSTRONG, D. B. Favor-

able Aspects of Heart Disease. Metropolitan Life Insurance Company, 1933.

(2) BRUNTON, F. F. Assistant Actuary. John Hancock, Mutual Life Insurance Company. Personal communication.

(3) LEVENE, G., WHEATLEY, F. E., and MATTHEWS, H. Roentgen Diagnosis of Coronary Disease. *Am Jour Roentgenol and Rad Ther*, 1934, 31, 588.

(4) CUNNINGHAM. Textbook of Anatomy, Sixth Ed. Oxford University Press, 1931.

(5) BOYD, WILLIAM. Textbook of Pathology. Lea & Febiger Philadelphia, 1934.

(6) KAUFMAN, EDWARD. Pathology (translated by Reiman). F. Blakiston's Sons & Co., Philadelphia, 1929.

(7) LEVINE, S. A. and BROWN, C. L. Coronary Thrombosis. Its Various Clinical Features. *Medicine*, 1929, 8, 245.

(8) REID, W. D. The Heart in Modern Practice. Lippincott Co., Philadelphia, 1928.

(9) WHITTEN, M. B. The Relation of the Distribution and Structure of Coronary Arteries to Myocardial Infarction. *Arch Int Med*, 1930, 45, 383.

(10) Idem. The Coronary Circulation as Related to Myocardial Infarction. *Proc Staff Meetings of Mayo Clinic*, 1929, 4, 130.

(11) WHITE, P. D. Heart Disease. Macmillan Co. New York, 1937.

(12) LEVENE, G., and REID, W. D. Differential Diagnosis of Organic Heart Disease by the Roentgen Ray. *Am Jour Roentgenol and Rad Ther*, 1932, 28, 466.

(13) REID, W. D., and LEVENE, G. Roentgenologic Consideration of Mitral Heart Disease. *New Eng Jour Med*, 1932, 206, 1027.

(14) VAQUEZ, H. Diseases of the Heart. W. B. Saunders Co., Philadelphia, 1924.

(15) SCOTT, W. G., and MOORE, S. Roentgenkymography. Its Clinical and Physiological Value in the Study of Heart Disease. *Ann Int Med*, 1936, 10, 306.

(16) SCOTT, W. G., MOORE, S., and MCCORDOCK, H. A. Roentgen Kymographic Studies of Cardiac Conditions. *RADIOLOGY*, February 1937, 28, 196.

(17) LEVINE, S. A. Clinical Heart Disease. W. B. Saunders Co. Philadelphia, 1936.

graphically, in terms of pathological processes concerned either with the formation or the absorption of cerebrospinal fluid

Results—In 208 cases in which a careful follow-up was made,¹ 44 patients had exchanges in excess of the normal limits established (See Interpretation 2) The high incidence of these cases probably reflects only the fact that the procedure is reserved for patients in whom cerebral atrophy is frequently present However, it is interesting to note that, in spite of the relatively large injections of gas in these cases, only eight patients showed an apparent slight delay in the rate of absorp-

tion of ethylene This probably reflects the large margin of safety existing normally in the absorptive mechanism, but may also indicate that our criteria for the limits of normal injection may be somewhat too conservative The remaining 164 cases were considered suitable material for the proposed study

The clinical types represented in these 164 patients are shown in Table I, together with the roentgenographic interpretation of the size of the ventricular and subarachnoid spaces and the estimated rate of absorption of cerebrospinal fluid

Thirty-four patients showed an ab-

TABLE II—NON TUMOR PATIENTS WITH ESTIMATED DELAYED RATE OF ABSORPTION—SLOW C S F FORMATION?*

Case	Age	Sex	Clinical Diagnosis	Encephalographic Data						Estimated Rate of Absorption
				Initial pressure (mm H ₂ O)*	Volume (cc) of Gas Injected	Size of Ventricles	Filling of Subarachnoid Spaces	Size of Basal Cisterns	Diagnosis	
C S	13	F	Disseminated myelocnecephalitis	100	100	Large normal	Normal (?) slight cortical atrophy	Slightly dilated	Normal	Slightly delayed
J A	22	M	Convulsive state (post traumatic)	800	130	Large normal R > L	Small channels diffusely scattered over cortex	Dilated	Atrophy of rt cerebrum	Moderately delayed
R Ja	1	M	Mongolian idiot	270	60	Large normal	Dilated	Large	Cortical aplasia	Slightly delayed
G T	27	M	Convulsive state (rt Jacksonian)	500	125	Normal	Normal	Normal	Normal	Moderately delayed
Z B	24	M	Rt hemiparesis and hemihypesthesia etiology(?)	490	110	Normal	Normal	Normal	Normal	Moderately delayed
D M	2	M	Convulsive state (idiopathic)	310	65	Slightly dilated (?)	Normal	Normal	Normal	Markedly delayed
R Ju	7 mos	M	Convulsive state (mal development CNS)	220	70	Dilated	Dilated especially in frontal and occipital areas	Dilated	Cerebral agenesis	Markedly delayed

* Initial C S F pressure taken in sitting position and under anesthesia

¹ Other patients lacking adequate follow up data or in whom an unsatisfactory filling occurred, were not included

normal delay in the disappearance of the ethylene gas These patients may be con-

logical process in the absorptive mechanism?

The factors involved in the disappearance of ethylene or other gases from the

4 The pressure and temperature of the system

As applied to the conditions involved in the absorption of ethylene following its

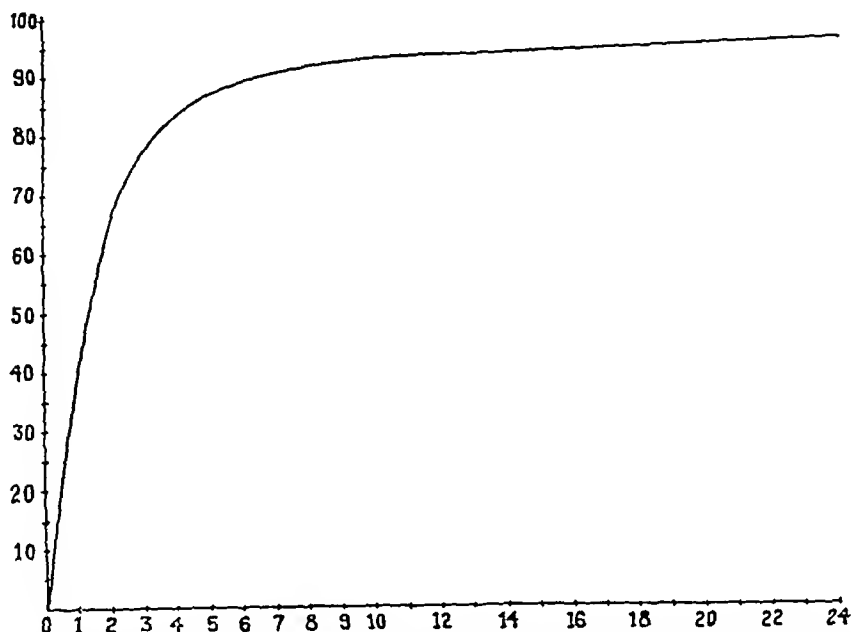


Fig 1 Curve representing the estimated lower limits of the 'normal' rate of absorption of ethylene gas following its encephalographic injection. The time in hours is indicated on the abscissa and the estimated percentage absorption of ethylene on the ordinate

ventricles and subarachnoid spaces are undoubtedly numerous. The fact that the rate of disappearance closely corresponds to the solubility of the various gases indicates that solubility is perhaps the most important single factor. The comparative rates of disappearance of ethylene, nitrous oxide, oxygen, and air have been estimated in previous experimental work (2). When variations of the rate of disappearance for the same gas are considered, however, the explanation is not so obvious.

The factors known to affect the rate of absorption of a gas by a fluid may be listed as follows:

- 1 The rate of exchange of fluid
- 2 The relative volumes of gas and fluid
- 3 The surface contact area between gas and fluid

encephalographic injection these factors would be:

- 1 The rate of formation and absorption of cerebrospinal fluid
- 2 The volume of ethylene and cerebrospinal fluid exchanged and the estimated volume of cerebrospinal fluid not drained in the process of encephalography
- 3 The area of surface contact between the ethylene and the cerebrospinal fluid as determined by the spatial characteristics of the ventricular and subarachnoid spaces
- 4 The cerebrospinal fluid pressure
Body temperature

These factors will be further considered, individually, in the order listed.

1 Since the amount of a gas which may go into solution rapidly diminishes as the

the gas on the basis previously suggested (see Interpretation) cannot be accepted in these cases. Pathologic changes of the arachnoid villæ, as described by Fay and Winkelman (4) in a group of cases of cortical

the most likely explanation in this group (See Interpretation 1.) The exact nature of such a condition—atrophy of the choroid plexus or a physiological dysfunction—can only be conjectured.

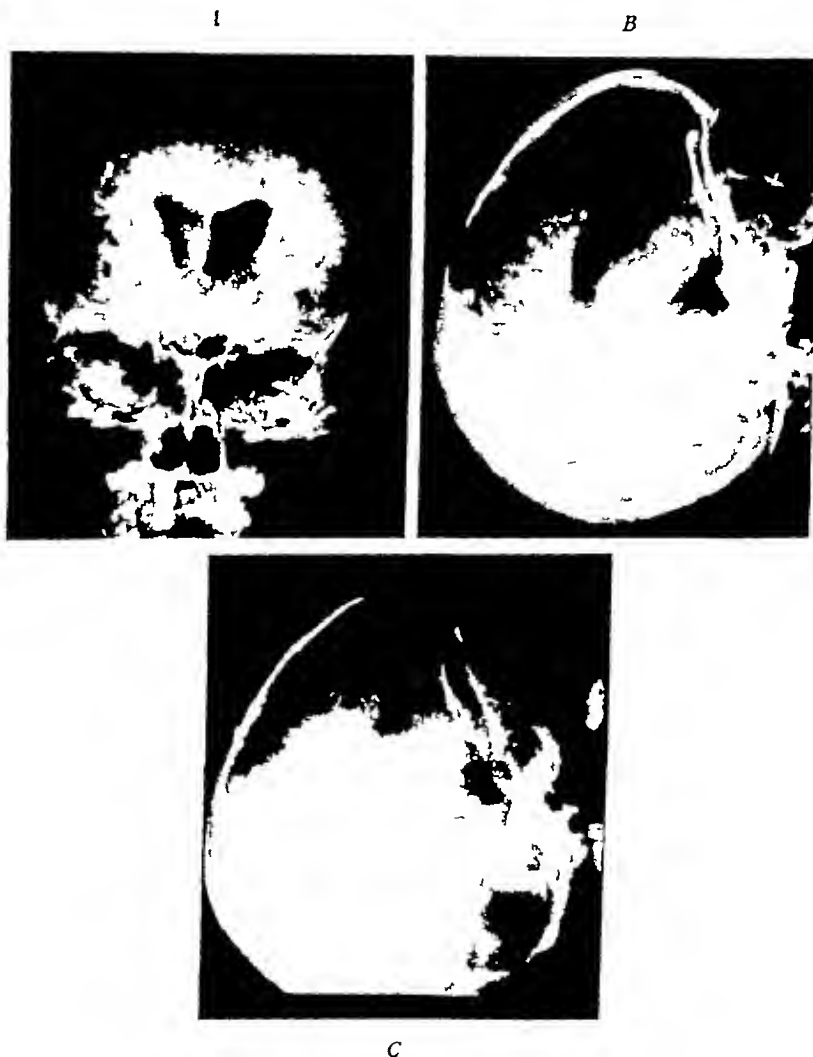


Fig 3 S A 4 years of age. Clinical diagnosis: Congenital defective volume exchange of CSF and ethylene gas. Normal encephalogram. (A) Anteroposterior projection. (B) Horizontal transverse projection initial view. (C) Horizontal transverse projection, three hour view, 90 per cent estimated absorption.

atrophy, likewise would not appear to explain this delayed absorption of gas, since such a block in the absorptive bed would scarcely be compatible with the normal, or even low, cerebrospinal fluid pressures observed in these cases. A sluggish flow of cerebrospinal fluid secondary to its subnormal formation would seem

Group II—In the remaining 27 cases the delayed absorption of gas was associated with a markedly limited filling, either general or asymmetrical, of the supracortical subarachnoid spaces. Ten of these 27 patients were tumor suspects in whom the obliteration of the subarachnoid spaces and blocking of the absorptive

mentioned. Evidence will be presented to show that the retardation in the absorption of ethylene occurring under such conditions is appreciable and, in case of a progressive lesion, definitely antedates any true delay in the absorption of the cerebrospinal fluid. Beyond the critical point which marks the limit of the normal margin of safety in the absorptive mechanism, increased cerebrospinal fluid pressure, hydrocephalus, and further retardation in the absorption of gas occur. It may be concluded that, in the presence of small and poorly filled subarachnoid spaces, with ventricles of normal size (aside from any distortion or shift) and normal cerebrospinal fluid pressure, a slightly delayed rate in the absorption of the gas suggests an early lesion tending to obliterate a portion of subarachnoid spaces or absorptive bed, but which is not sufficiently advanced to render the total absorptive mechanism inadequate for the absorption of all the cerebrospinal fluid formed. Also, if the encephalographic picture were essentially the same, *i.e.*, ventricles of normal size and small or poorly filled subarachnoid spaces, and yet the rate of absorption of the

gas was normal, the poor subarachnoid filling would be best explained on the basis of a chance, inadequate filling, and should not be interpreted as abnormal.

4 The fourth factor—pressure—is a minor and almost negligible one in affecting the rate of absorption of the gas, since the cerebrospinal fluid pressure was essentially normal in all the patients submitted to encephalography and the variations of the cerebrospinal fluid pressure subsequent to encephalography are roughly comparable. In cases of suspected brain tumor encephalography has been performed only when evidence of increased intracranial pressure was slight or absent and preliminary lumbar puncture in the horizontal position showed that the cerebrospinal fluid pressure was not raised appreciably over 200 mm of water. Since the variations of body temperature are relatively slight in these cases, this factor may safely be disregarded.

Thus, with the qualifications considered above in mind, it seems that, in properly selected cases, it should be possible to interpret a delay in the rate of the disappearance of ethylene, injected encephalo-

TABLE I

Clinical Diagnosis	No of Cases	Size of Ventricles		Size of Subarachnoid Spaces				Estimated Rate of Absorption	
		Normal	Dilated	Normal	Dilated	Little or no gas	Asymmetrical	Normal	Delayed
Meningo-encephalitis	10	4	6	1	2	6	1	2	8
Brain tumor suspects	26	19	7	4	6	7	9	16	10
Convulsive state (idiopathic)	56	48	8	39	4	9	4	52	4
Convulsive state (post traumatic)	23	18	5	8	5	6	4	20	3
Post traumatic head syndrome	6	6	0	2	2	1	1	5	1
Cerebro vascular disease	8	5	3	1	6	0	1	8	0
Maldevelopment of C N S * (Congenital infectious post traumatic)	22	11	11	6	8	6	2	18	4
Psychoneurosis	2	2	0	2	0	0	0	2	0
Miscellaneous	11	8	3	6	1	3	1	7	4
Total	164							130	34

* Central nervous system

findings were limited to scars and hyperesthesia on the forehead and the right fronto-parietal region, a positive Hoffman's sign on the left, and slightly increased biceps and Achilles reflexes on the left side

Lncephalogram—This showed "large normal" ventricles with the anterior horns slightly shifted to the right. The sub-arachnoid spaces were normal on the left, but did not show in the right frontal and parietal regions, especially in the neighborhood of the old burr hole. Of the 150 c c of ethylene injected, 80 per cent

had disappeared in four and a half hours, and 85 per cent in seven and a quarter hours. The rate of disappearance of the ethylene gas was estimated to be slightly delayed in comparison with the "normal curve" (Fig 1)

Diagnosis—Cerebral scar and cortical adhesions—right frontal

Operation—Revealed a cortical scar in the right frontal lobe. A right frontal lobectomy was performed

Pathological Study—Showed a moderately adherent arachnoid which, on micro-

veniently subdivided into two groups on the basis of the encephalographic findings (1) those who presented normal or dilated subarachnoid spaces and (2) those who

absorption of gas occurred in the presence of normal or slightly dilated subarachnoid spaces. The details of these cases are presented in Table II. Since the gas

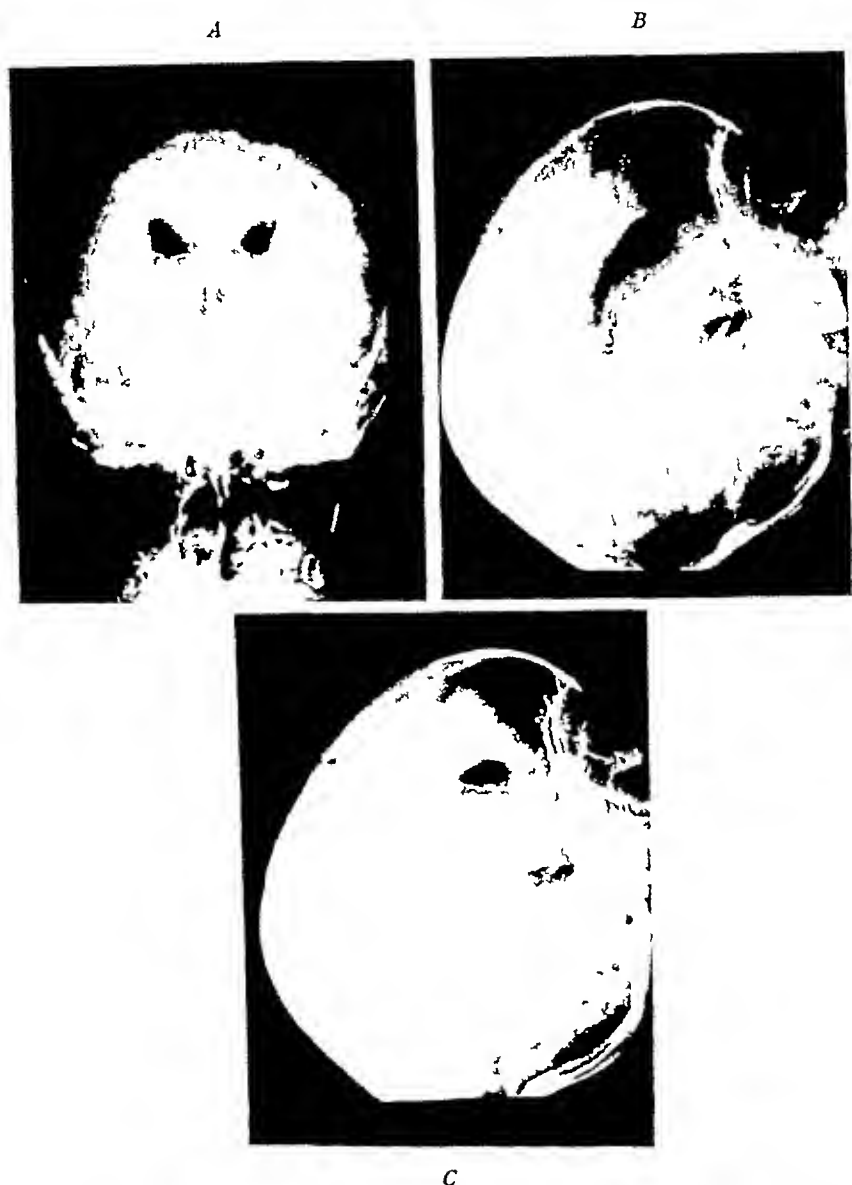


Fig 2. L. C. female 5 years of age. Clinical diagnosis: Right hemiplegia, etiology (?), two-year duration, 80 c.c. volume exchange of C.S.F. and ethylene gas. Roentgenographic diagnosis: Hydrocephalus. Follow-up views were taken at 5, 7, and 24 hours and show a slightly delayed rate of absorption of the ethylene gas. For further details, see Table III. Note the absence of subarachnoid filling. (A) Anteroposterior projection. (B) Horizontal transverse projection, initial view. (C) Horizontal transverse projection, 24-hour view, 90 per cent estimated absorption.

failed to show a proper filling of the supracortical subarachnoid spaces.

Group I—In seven instances a delayed

reached the supracortical spaces through normal or dilated subarachnoid channels, a delay in the rate of the disappearance of

TABLE III—NON-TUMOR PATIENTS WITH ESTIMATED DELAYED RATE OF ABSORPTION—
ABSORPTIVE BLOCK

Case	Age	Sex	Clinical Diagnosis	Encephalographic Data						Estimated Rate of Absorption
				Initial CSF Pres- sure (mm Hg)*	Volume (cc) of Gas Injected	Size of Ventricles	Fillings of Subarachnoid Spaces	Size of Basal Cisterns	Diagnosis	
M P	14	F	Lawrence Moon Bie- dle Syn- drome	565	97	Slightly dilated	Only a few streaks in frontal areas	Dilated	Absorptive block (?)	Slight de- lay (?)
A K	25	M	Cephalagia since influ- enza 2 years before	620	104	L (?) slightly dilated	Slight asym- metry R > L	Normal	Left cortical adhesions Right cortical adhesions (?)	Slight de- lay (?)
C C	28	M	Convulsive state etiol- ogy (?)	510	145	Slightly dilated	Very little gas	Dilated	Early hy- drocephalus (?)	Slightly delayed
K T	21	M	Convulsive state after brain abscess —rt frontal	545	150	Large normal	Little or no gas in rt fronto- parietal area	Normal	Rt frontal adhesions	Slightly delayed
L C	5	F	Rt hemiple- gia, etiology (?)	—	80	Slightly dilated	Very little gas	Dilated	Hydro- cephalus	Slightly delayed
E A	1 1/2	F	Microcephaly —mental re- tardation	220	60	Greatly dilated	No gas	No gas	Cortical adhesions (?)	Slightly delayed
A P	25	M	Convulsive state etiol- ogy (?)	520	125	Large normal	Only slight streak- ing in frontal areas	Normal	Normal	Slightly delayed
R M	16	M	Convulsive state since meningo- encephalitis	645	120	Dilated with cyst	Little or no gas	Dilated	Porencephalic cyst	Slightly delayed

bed presumably were caused by a space-consuming lesion. The other 17 cases may conveniently be considered separately.

Non-tumor Group with Delayed Absorption—The work of Key and Retzius (8), confirmed by Weed (14) and Naffziger (11), again more recently by the studies of Iwanow and Romodanowsky (7) and Spiegel and Sommer (13), demonstrated that the main bed for the absorption of cerebrospinal fluid is situated in the subarachnoid spaces overlying the cerebral hemispheres. In cases of delayed absorption, therefore, direct involvement of this absorptive bed or of the channels leading to it, is to be suspected. The presence of arachnoid adhesions secondary to a meningo-encephalitic process, either infectious or traumatic in origin, is a possibility which must be considered in such cases. The encephalographic picture in this group is characteristic. Failure of proper filling or an asymmetrical filling in the supracortical subarachnoid spaces with or without dilated ventricles and basal cisterns has constituted the picture associated with the delayed absorption (Fig. 2). The poor subarachnoid filling is often passed over and the dilated ventricles, when present, have been considered within the upper limits of normal, or possibly a cerebral atrophy or early hydrocephalus. Compare these pictures with the normal as illustrated in Figure 3.

Of the 17 patients showing this condition, that is, a poor supracortical subarachnoid filling associated with a delayed absorption of the gas, two (namely, M. P. and A. K.) were borderline cases and have been included only because the suggested delayed rate of absorption seemed the best explanation of both their clinical and encephalographic findings. A meningo-encephalitic process of infectious or traumatic origin was compatible with the clinical findings in all these cases and was definitely suggested in 12 of them. The pertinent data in connection with these cases are presented in Table III.

On the basis of ventricular enlargement

and an encephalographic injection of gas beyond the limits established for a proper interpretation of the rate of absorption of the gas in this procedure, it might be argued that two cases in this series, namely, E. K. and R. H. (see Table III), have been improperly included. In these instances, however, the delay in absorption was unusually marked and seemed out of proportion to the slight delay which might have been expected from the degree of ventricular dilation and the amount of gas injected. For this reason and because, in addition, they seem best explained clinically on the basis of a meningo-encephalitis, they have been included as examples of the more advanced stages of the condition under consideration. In the presence of the normal cerebrospinal fluid, and normal cerebrospinal fluid pressure found in these patients, their encephalographic findings must be accounted for by an old meningo-encephalitic process of sufficient severity to have left the structural changes observed and yet not of sufficient severity to have produced a permanent functional decompensation in their absorptive mechanisms.

In one of these cases operation afforded opportunity for a correlation of the pathologic changes with the encephalographic findings and delayed rate of absorption.

Protocol—K. T., 21 years, of age, male.

History—Six years ago this patient was hit on the head by a baseball. He suffered an acute septic condition of scalp three weeks later. Subsequently a right frontal abscess was diagnosed. An abscess in the right frontal region was drained six weeks later. This frontal abscess had been aspirated three times in the past six years—the last time one year before entry “without success.” This patient's complaints were headaches at time of aspiration, slight subjective hemipareses after a series of aspirations, and generalized, non-focal convulsions for the last three and a half years.

Examination—The positive contributive

limited areas of adhesions were found about the left frontal lobe near the site of the cortical scar, which had been demonstrated by the encephalograms and which was excised by lobectomy. The normal rate of absorption in these cases seems entirely compatible with such a sharply delimited involvement of the meninges.

The fourth patient, L G, gave clinical evidence of a post-encephalitic condition. The convulsive state and mental retardation dated from a period of infections of

ears and sinus at the age of one and a half years. However, the usual sequelæ of encephalitis—cerebral atrophy or cortical adhesions—were not demonstrable by encephalography and the rate of absorption tended to corroborate the essentially normal findings in this case.

In the fifth patient, D H, the encephalographic findings in some respects suggested a cortical scar, but the lack of any history or clinical findings which would tend to corroborate this diagnosis, as well as the

TABLE IV—NON-TUMOR PATIENTS WITH ESTIMATED NORMAL RATE OF ABSORPTION—MENINGO-ENCEPHALITIS AND SUSPECTED CORTICAL ADHESIONS

Case	Age	Sex	Clinical Diagnosis	Encephalographic Data					Estimated Rate of Absorption
				Initial CSF Pressure (mm H ₂ O)*	Volume (cc) of Gas Injected	Size of Ventricles	Filling of Subarachnoid Spaces	Size of Basal Cisterns	
O K	17	M	Chronic leptomenigitis	335 prone	170	Normal	Normal	Normal	Normal
J H	39	M	Chronic arachnoiditis	540	11	Normal	Little gas	Normal	Normal
B K	8	F	Lt frontal cortical scar and adhesions	270	70	Lt dilated, Rt normal	Poor filling	Normal	Lt frontal cortical scar
L G	10	F	Jacksonian epilepsy mental retardation post encephalitic (?)	380	72	Normal	Normal	Normal	Normal
D H	18	M	Convulsive state idiopathic	340	95	Dilated	Normal	Normal	Cortical scar (?)
W P	27	M	Convulsive state idiopathic	260	70	Normal	Very little gas	Normal	Adhesions
M S	1 1/2	M	Convulsive state post traumatic	550	60	Normal	R > L	Dilated	Adhesions Lt cortex
M E	8	F	Convulsive state post traumatic (?)	440	75	Normal	R < L	Normal	Adhesions Rt cortex
W C	1	M	Lt hemiplegia—birth injury	265	55	Normal	R < L	Normal	Cortical adhesions on rt (?)
D B	19	M	Jacksonian epilepsy etiology (?)	460	135	Normal	Poor filling	Normal	Cortical adhesions (?)
B J	4	F	Mental retardation agenesis	530	90	Normal R > L	Slight asymmetry R < L	Dilated	Cortical adhesions (?)

* Initial CSF pressure taken with patient in sitting position and under anesthesia

scopic examination, was found to be greatly thickened

The partial block in the absorptive bed in this case, as shown in the encephalograms and verified pathologically, seems to agree with the findings of only mildly dilated ventricles and a delayed absorptive rate of slight degree

As a corollary to this group which showed a delayed absorption of gas, it is interesting to consider those patients who were diagnosed as having a meningo-encephalitic process, but who did not show a delayed rate of absorption. The essential facts in these cases are presented in Table IV

One patient, O K, a boy 17 years of age, with undeniable clinical and laboratory evidence of a low grade encephalitis (corroborated by a burr hole exploration), presented no ventricular or subarachnoid abnormality upon encephalography and furthermore had a normal rate of absorption of the ethylene gas. This patient was followed through to eventual complete clinical recovery

In the second patient, J H, an arachnoiditis in the left temporal region over an area 4 X 6 cm in size was demonstrated at operation. Likewise, in patient B K,

Agencsis, cortical adhesions (?)	Slightly delayed
Cortical adhesions (?)	Slightly delayed
Cortical scar - adhesions	Slightly delayed
Cortical adhesions	Slightly delayed
Cortical adhesions	Slightly delayed
H y d r o cephalus	Markedly delayed
H y d r o cephalus	Markedly delayed
H y d r o - cephalus	Markedly delayed
Normal	very markedly delayed

proved cortical adhesion in the right frontoparietal region

The failure of subarachnoid filling, as seen in the patients W P and D B, is not uncommon and, alone, can scarcely justify

difficult encephalographic injection of ethylene, in the case of W P, contributed to the impression of arachnoidal adhesions about the spinal cord. Clinically, both patients presented convulsive states of unknown

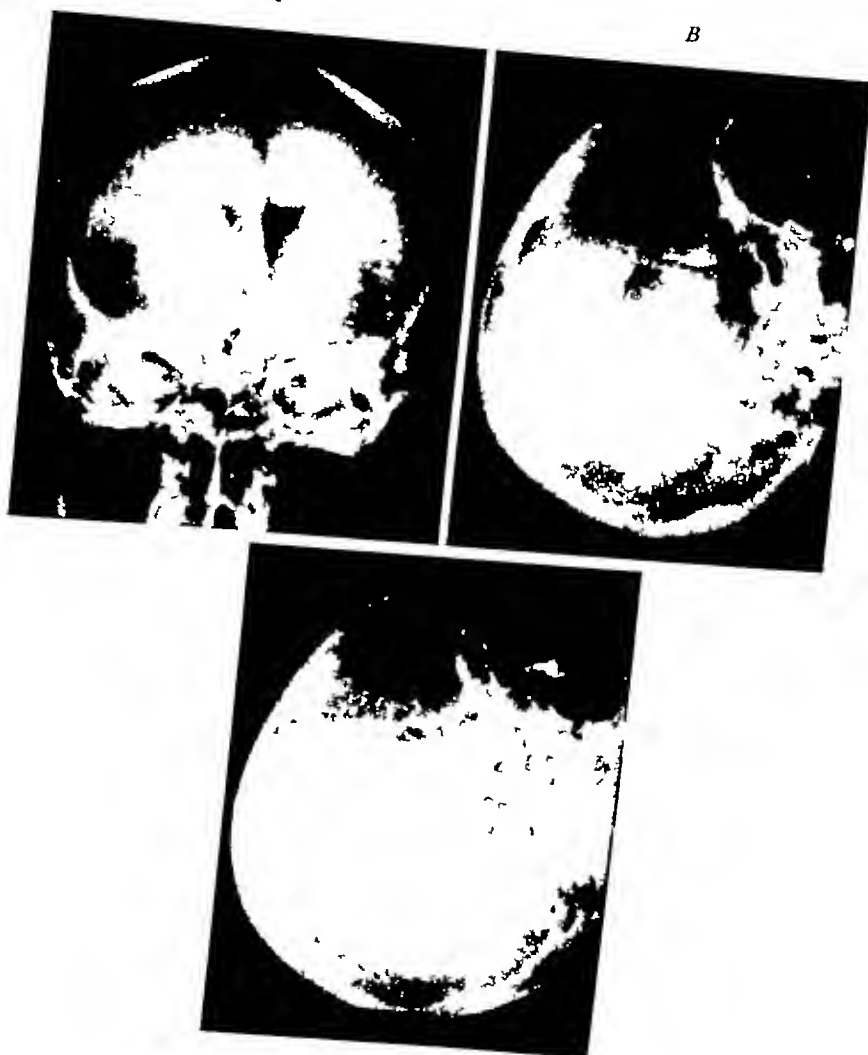


Fig 4. G W female 37 years of age. Clinical diagnosis: Right frontal brain tumor, 20 months' duration of symptoms. 100 cc volume exchange of CSF and ethylene. The rate of absorption of the ethylene was estimated to be slightly delayed. For further details see Table V. A: Note the absence of subarachnoid gas on the side of the tumor which is indicated by the shift of the falx cerebri and the lateral ventricles, the posterior displacement and distortion of the right anterior horn and by the erosion of the right superior bony orbit. Roentgenographic diagnosis: Right frontal tumor. (A) Anteroposterior projection. (B) Horizontal transverse projection, initial view. (C) Horizontal transverse projection, six-hour view. 80 per cent estimated absorption.

the diagnosis of cortical adhesions. A etiology with little in their histories, physical findings or examinations of the cerebrospinal fluid and

A G	8	M	Lt hemiparesis and Jacksonian epilepsy since meningitis	640	110	Normal	No gas except in area of Islt of Reil on rt	Dilated
M M	23	M	Hemiparesis and Jacksonian epilepsy since meningoencephalitis	630	136	Dilated	Slight streaking only	Dilated (?)
J I	17	M	Convulsive state since depressed lt frontal fracture	600	120	Rt dilated, L normal	Chiefly frontal streaking 'R > L	Dilated
J O	10	F	Lt hemiparesis and convulsive state since meningitis	400	70	Dilated R > L	Only few streaks in left frontal region	Dilated
D T	10	F	Spastic paraplegia—birth trauma	500	75	Dilated	Only slight frontal 'streaking'	Dilated
I K	18	M	Convulsive state following meningoencephalitis	470	100	Dilated	Only slight frontal streaking	Dilated
R H	11	M	Convulsive state Mental retardation Encephalitis (?)	500	120	Dilated	Very little gas	Dilated
R S	33	M	Jacksonian epilepsy post traumatic	220 (prone)	135	Dilated	Only slight frontal streaking	Dilated
J B	7	M	Mental retardation post traumatic head syndrome	540	60	Normal	No gas	Dilated

* Initial C S F pressure taken with patient in sitting position and under anesthesia

tionable shift of the ventricular system to the right. Little or no gas could be discerned in the supracortical subarachnoid spaces. A ventriculogram was performed on the patient four months later and showed a striking change. The right ventricle was considerably dilated. The anterior horn of the left ventricle was also dilated, while the body was compressed. The anterior portion of the third ventricle was dilated, while the posterior portion appeared obliterated. There was a marked shift of the ventricular system to the right. No gas was visualized in the subarachnoid spaces. The marked increase in the dilatation of the ventricle with the advancement of the condition strikingly illustrates the process in its progression from the early to the terminal stages. The tendency for dilated ventricles to occur with obliterated subarachnoid spaces and for this combination to be associated with a retarded rate of absorption thus simulates the picture found in meningo-encephalitic conditions as previously discussed. The clinical course, however, as well as the shift and distortion of the ventricular system, clearly differentiates the cases of brain tumor.

In this connection it is interesting to conjecture on the abnormal cerebrospinal fluid dynamics accompanying brain tumors. The explanation of an increased intracranial pressure in the presence of ample and incompletely collapsed ventricles has not been clear on a simple, space-consuming basis. Obliteration of space in the smaller and more susceptible subarachnoid spaces over the cerebral cortices, or similar blockage of the cerebrospinal fluid pathways at the narrow subarachnoidal channel of the incisura might well produce a progressively increasing pressure commensurate with the degree of absorptive block. The actual obliteration of the subarachnoid spaces, evidenced by encephalography and checked by operative observation, in combination with dilatation of these ventricular spaces (not necessarily distorted or compressed), and the finding of delayed rates of absorption in the more advanced stages, strongly support

this explanation. The progression of changes as illustrated in the case of M. R. contributes to the same interpretation.

Discussion—It is an interesting fact that, in the group of patients with brain tumor (Table V), ventricular dilatation was found to a slight degree in only four of the ten cases showing a delayed rate of absorption, whereas in the corresponding group of patients who did not have tumor (Table III) definitely normal ventricles were found in only two of the 17 patients showing the delayed rate of absorption. Furthermore, the degree of ventricular dilatation in this latter group tended to be far more advanced than in the case of the tumor group. The explanation of these facts must be sought in a proper interpretation of the absorption of gas following encephalography with ethylene, keeping in mind the clinical conditions associated with the delayed absorption.

As suggested (see under Interpretation 3), a delayed rate of disappearance of the gas may merely reflect an early obliteration of the subarachnoid channels and does not necessarily indicate a true retarded absorption of cerebrospinal fluid. In this early stage the retarded disappearance of the gas is consistent with ventricles of normal size, and normal cerebrospinal fluid pressure. The two patients without tumor, with ventricles of normal size, and the majority of patients with tumor, would seem to fit into this category. If the process is progressive, as in the case of a tumor or chronic, low-grade leptomeningitis, this early change foreshadows the alterations to come with progressive blocking of the absorptive bed, namely, dilatations of the ventricles and basal cisterns in the presence of increased cerebrospinal fluid pressure.

If such a process should regress at any stage, as might occur in the case of an acute encephalomeningitis, residual structural changes might be found associated with a delayed rate of absorption of gas. The structural changes would consist of more or less obliterated, supracortical, subarachnoid spaces, with or without dilated ventricles and basal cisterns—depending upon

symmetrical subarachnoid filling and normal rate of absorption of the gas in the encephalogram, made this diagnosis unlikely

In six other patients cortical adhesions had been suspected on the basis of asymmetrical or poor subarachnoid filling over the cortex. The ventricles were not abnormal, however, and the rate of absorption was definitely within normal limits. Although an adhesive process of circumscribed character might well be compatible with a normal rate of absorption, as dem-

onstrated in patients J H and B K, an asymmetrical subarachnoid filling involving the spaces over one entire cerebrum, such as was present in four patients, and the lack of filling over both cerebral hemispheres, as seen in the other two, can scarcely be explained on such a basis. The accuracy of the method is sufficient to detect such gross blocks in the absorptive bed, and probably is adequate to show a delayed rate of absorption when approximately one-fifth of the absorptive bed is involved, as previously illustrated in the case of

TABLE V-A—TUMOR SUSPECT PATIENTS WITH ESTIMATED DELAYED RATE OF ABSORPTION

Case	Age	Sex	Clinical Diagnosis	Encephalographic Data						Estimated Rate of Absorption
				Initial Pressure (mm H ₂ O)*	Volume (cc) of Gas Injected	Size of Ventricles	Filling of Subarachnoid Spaces	Size of Basal Cisterns	Diagnosis	
M M	35	F	Lt temporo parietal glioma (verified)	625	91	Normal R > L	No gas	Normal	Tumor	Markedly delayed
J F	35	M	Rt temporal glioma (verified)	540	135	Normal	R < L Marked asymmetry	Normal	Tumor	Moderately delayed
M R	44	M	Lt temporal tumor (died—no autopsy)	540	130	Normal	Little or no gas	Normal	Tumor	Moderately delayed
G W	37	F	Rt frontal meningioma (verified)	420	100	Normal R < L	R < L Chiefly left frontal	Normal	Tumor	Moderately delayed
A J	17	M	Osteoma of skull	575	85	Normal	Only slight in frontal areas	Normal	Tumor	Slightly delayed
A A	30	M	Lt temporal hemangioma (verified)	550	132	Slightly dilated	Few streaks in frontal areas	Slightly dilated	Tumor	Slightly delayed
R H	28	F	Rt frontal astrocytoma (verified)	920+	90	Rt dilated Lt no gas	No gas	Normal	Tumor	Markedly delayed
W C	33	M	Brain tumor(?)	750	125	Dilated	No gas	No gas	Tumor (?)	Slightly delayed
F T	26	F	Lt frontal cholesteatoma (verified)	620	92	Rt dilated R > L	Little or no gas	Normal	Tumor	Slightly delayed
E E	32	M	Rt temporo parietal tumor	600	130	Normal (?)	Lt normal Rt no gas	Normal	Tumor (?)	Moderately delayed

tricles and subarachnoid spaces should be carefully re-examined for possible abnormality

CONCLUSIONS

1 The rate of disappearance of ethylene gas following its encephalographic injection may be estimated by means of follow-up roentgenograms, and, in properly selected cases, may be correlated with the presence or absence of pathological processes involving the supracortical subarachnoid spaces and the mechanism concerned with the formation and absorption of cerebrospinal fluid

2 In a few instances a delayed rate of absorption occurred in the presence of normal or dilated subarachnoid spaces. The possibility of faulty formation of cerebrospinal fluid is suggested in this group

3 The majority of patients showing a delayed absorption have presented the characteristic findings of little or no gas in the subarachnoid spaces or an asymmetry of the subarachnoid filling. This condition has been observed in cases of brain tumor and in extensive supracortical arachnoidal adhesions of infectious or traumatic origin. Dilatations of the ventricles and basal cisterns occurred in the majority of cases of the latter type. An interpretation of the findings in these cases, as well as in others, is presented

4 The use of this procedure is of distinct diagnostic value in corroborating and clarifying the usual static interpretation of encephalograms

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fessor of Surgery, Robert S. Stone, M.D., Associate Professor of Roentgenology, Charles Capp, M.D., Assistant Professor of Roentgenology, O. W. Jones, Jr., M.D., Associate Professor of Surgery

BIBLIOGRAPHY

- (1) AIRD, R. B. Experimental Encephalography with Anesthetic Gases. *Arch Surg*, February, 1936 32, 193-217
- (2) Idem. Encephalography with Anesthetic Gases. *Arch Surg* May 1937 34, 853-867
- (3) DANDY, W., and BLACKFAN, K. D. Internal Hydrocephalus. *Jour Am Med Assn*, 1913 61, 2216-2217, *Am Jour Dis Child*, 1914, 8, 406-482, and 1917 14, 424-443
- (4) LAY, T., and WINAELMAN, N. W. Widespread Pressure Atrophy of the Brain and its Probable Relation to the Function of the Pacchionian Bodies and the Cerebrospinal Fluid Circulation. *Am Jour Psychiat*, January, 1930 9, 667-685, *Jour Am Med Assn* Jan 25 1930 94, 245-250
- (5) FOHRSTER, O. H. Encephalographische Erfahrungen. *Ztschr f d ges Neurol u Psychiat*, 1924-1925, 94, 512-584
- (6) GUTTMANN, L. Ueber Störungen der Liquorresorption bei Psychosen. *Arch f Psychiat*, 1929, 88, 211-225
- (7) IWANOW, G., and ROMODANOWSKY, K. Ueber den anatomischen Zusammenhang der cerebralen und spinalen submeningealen Räume mit dem Lymphsystem, Methodik und wichtigste Beobachtungen. *Ztschr f d ges Exper Med* 1927, 58, 596-607
- (8) KEY, and RETZIUS. Anatomie des Nervensystems und des Bindegewebes. Stockholm 1876
- (9) KLAUBER, F. Postencephalitische Störungen der Liquorresorption. *Ztschr f d ges Neurol u Psychiat*, 1925 97, 266-277
- (10) MEHRTENS, H. G., and WEST, H. F. The Absorption of Phenolsulphonphthalein from the Subarachnoid Space in Diseases of the Central Nervous System. *Arch Int Med* 1917 20, 575-585
- (11) NAFFZIGER, H. C. Personal communication.
- (12) NIPPERT. Ueber die Beziehungen der Blutliquorschanke zum Gesamtstoffwechsel. *Ztschr f d ges Neurol u Psychiat*, 1929 118, 562-574
- (13) SPIEGEL, E. A., and SOMMER, I. Ophthalmological and Oto-Neurology. Julius Springer Vienna and Berlin 1931
- (14) WEED, L. H. Studies on Cerebrospinal Fluid. Nos. II, III and IV. *Jour Med Research* 1914 M S 26, 31, 21-118
- (15) WESTON, P. G. Phenolsulphonphthalein Absorption from the Subarachnoid Spaces in Paresis and Dementia Praecox. *Arch Neurol and Psychiat*, 1921 5, 58-63

brospinal fluid to suggest a meningo-encephalitis

Anatomical variations or possibly deflecting (not obstructive) adhesions about the base would seem to be a more likely explanation in the four cases of asymmetrical filling of the subarachnoid spaces

The value of this functional check on the usual x-ray interpretation is thus of service not only in corroborating the diagnosis of cortical pathology, presumably of post-traumatic or meningo-encephalitic origin, but also in differentiating from this group certain other cases which would have been so classified by the usual methods

Brain Tumor Patients with Delayed Absorption—Of 26 patients suspected of brain tumor (see Table I), in whom the cerebrospinal fluid pressure was sufficiently low to permit the use of encephalography, the diagnosis of brain tumor was made in 16 cases, either by the encephalograms or by pathological examination, while the possibility of tumor was ruled out by the encephalographic findings in nine of the remaining ten patients. Ten of those diagnosed as having brain tumors showed abnormally slow rates of absorption of ethylene,

and the other six were estimated to have normal rates of absorption. The pertinent data on these 16 cases of tumor are presented in Table V-A. Although such an analysis of these cases does not permit clear-cut explanation of a delayed rate of absorption in ten of the patients, as opposed to a normal rate in the other six in whom the diagnosis of tumor was made, the patients with delayed absorption had, for the most part less gas in the subarachnoid spaces, and in this respect tended to simulate the usual appearance of a ventriculogram (Fig 4).

Also worthy of note in this connection is the fact that dilated ventricles occurred much more frequently in the group showing a delayed absorption rate. In fact, in the group showing a normal rate of absorption ventricular dilatation was found in one instance only, and the diagnosis in this case was that of an intraventricular tumor (Table V-B).

That these differences are significant is suggested by the findings in the patient M R. In the initial encephalogram the right ventricle appeared a trifle larger than the left, which seemed slightly compressed and distorted. There was a ques-

TABLE V-B—TUMOR SUSPECT PATIENTS WITH ESTIMATED NORMAL RATE OF ABSORPTION

G M	56	F	Rt parietal meningioma (verified)	400	110	Normal R < L	Slight asymmetry R < L	Normal	Tumor	Normal
J L	26	F	Intraventricular tumor	630	130	Rt dilated, Lt normal	Slight asymmetry R < L	Normal	Tumor	Normal
R S	43	M	Rt temporo-parietal tumor	—	135	Normal R < L	Slight asymmetry R < L	Dilated	Tumor	Normal
C D	40	M	Rt fronto parietal astrocytoma (verified)	500	100	Normal	Slight asymmetry R < L	Normal	Normal	Normal
J S	48	M	Adenocarcinoma of choroid plexus (verified)	650	100	Normal R < L	Rt atrophy frontal, Lt normal	Normal	Tumor	Normal
E S	27	F	Cranio-pharyngeoma	500	145	Normal	Normal	Dilated	Tumor	Normal

* Initial C S F pressure taken in sitting position and under anesthesia (Avertin)

tricles and subarachnoid spaces should be carefully re-examined for possible abnormality

CONCLUSIONS

1 The rate of disappearance of ethylene gas following its encephalographic injection may be estimated by means of follow-up roentgenograms, and, in properly selected cases, may be correlated with the presence or absence of pathological processes involving the supracortical subarachnoid spaces and the mechanism concerned with the formation and absorption of cerebrospinal fluid

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BIBLIOGRAPHY

- (1) AIRD, R B Experimental Encephalography with Anesthetic Gases Arch Surg February 1936, 32, 193-217
- (2) Idem Encephalography with Anesthetic Gases. Arch Surg May 1937, 34, 853-867
- (3) DAVY, W, and BLACKFAN, K D Internal Hydrocephalus Jour Am Med Assn, 1913, 61, 2216-2217, Am Jour Dis Child, 1914, 8, 406-482, and 1917 14, 424-443
- (4) LAY, T, and WINKELMAN, N W Widespread Pressure Atrophy of the Brain and its Probable Relation to the Function of the Pacchionian Bodies and the Cerebrospinal Fluid Circulation Am Jour Psychiat. January, 1930, 9, 667-685, Jour Am Med Assn, Jan 25 1930 94, 245-250
- (5) GOERSTER O H Encephalographische Erfahrungen Ztschr f d ges Neurol u Psychiat., 1924-1925 94, 512-584
- (6) GUTTMANN, L Ueber Störungen der Liquorresorption bei Psychosen Arch f Psychiat., 1929 88, 211-225
- (7) IWANOW G and ROMODANOWSKY, K Ueber den anatomischen Zusammenhang der cerebralen und spinalen submeningealen Räume mit dem Lymphsystem, Methodik und wichtigste Beobachtungen Ztschr f d ges Exper Med. 1927, 58, 596-607
- (8) KEY and RETZIUS Anatomie des Nervensystems und des Bindegewebe. Stockholm 1876
- (9) KLAUBER, T Postencephalitische Störungen der Liquorresorption Ztschr f d ges Neurol u Psychiat., 1925, 97, 268-277
- (10) MEERTENS, H G, and WEST, H F The Absorption of Phenolsulphonphthalein from the Subarachnoid Space in Diseases of the Central Nervous System Arch Int Med, 1917, 20, 575-585
- (11) NAFFZIGER H C Personal communication
- (12) NIPPERT Ueber die Beziehungen der Blutliquorschanke zum Gesamtstoffwechsel Ztschr f d ges Neurol u Psychiat 1929, 118, 562-574
- (13) SPIEGEL E A and SOMMER, I Ophthalmological and Oto-Neurology. Julius Springer, Vienna and Berlin 1931
- (14) WEED L H Studies on Cerebrospinal Fluid Nos II III and IV Jour Med Research, 1914 M S 26, 31, 21-118
- (15) WESTON, P G Phenolsulphonphthalein Absorption from the Subarachnoid Spaces in Paresis and Dementia Praecox Arch Neurol and Psychiat., 1921 5, 58-63

the duration and severity of the acute process. Provided the residual absorptive mechanism was still adequate for the absorption of all cerebrospinal fluid formed, the cerebrospinal fluid pressure would be normal. Such an explanation would seem most likely in the patients without tumor, who showed dilated ventricles and basal cisterns.

Previous studies on the rate of absorption of cerebrospinal fluid have utilized the method of determination of urinary excretion of agents following their injection into the ventricular or subarachnoid spaces. Thus Dandy (3) used the dye phenolsulphonephthalein, and Foerster (5) used sodium iodide. Other workers, using the same methods or modifications of them, have reported rather striking delays in the appearance of the dye or iodide in the urine and prolonged duration of excretion in such conditions as schizoid stages, especially of the catatonic type (6), (15), cerebral syphilis (6, 12, 15) postencephalitic disorders, (9), and other organic diseases of the central nervous system (10), especially those involving the meninges. In individual cases, however, the tests have proved of little value. The obvious defect in these procedures has been that set amounts of the dye or iodide have been injected in all cases regardless of the volume of cerebrospinal fluid with which the dye or iodide was being diluted. As pointed out above (see under Interpretation 2), estimation of the rates of absorption cannot be made in individual cases without such knowledge. The follow-up observations on the rate of disappearance of ethylene, on the other hand, have the advantage that the sizes of the ventricles and subarachnoid spaces are shown by the encephalograms and the volume of the exchange of gas and fluid is determined at the time of injection. The estimation of the rate of absorption, because it is performed in conjunction with encephalography, is provided with the data which are essential for proper interpretation in the individual case.

As has already been brought out, delay in the absorption of ethylene following en-

cephalography does not necessarily indicate a delayed absorption of cerebrospinal fluid. Such a delay in the absorption of gas, however, does indicate either an abnormally slow formation of cerebrospinal fluid or a limited margin of safety in the absorptive mechanism. In the latter instance, when the process is progressive, the delayed absorption of gas foreshadows the changes to come when the margin of safety is overstepped, namely a delayed absorption of cerebrospinal fluid, an increased cerebrospinal fluid pressure, and hydrocephalus. The dyes and iodides, in that they are given in the form of solutions, would presumably correspond more closely with the cerebrospinal fluid in their absorptive characteristics. In early cases, in which obstruction was only partial, a delay in absorption, as occurs with the gas, could not be expected with such solutions, since actually absorption is occurring within normal limits. The absorption of gas, thus, serves as a delicate and early diagnostic test and, in this respect again, has a distinct advantage over the dye and iodide solutions.

In the interpretation of this procedure it must be remembered that it is an estimate, with rather wide variables involved, and, like all laboratory tests, is completely dependent for what accuracy it may possess upon the carefulness of its execution. As a single test, which ordinarily cannot be repeated on the same patient, it must be interpreted with caution, keeping in mind the condition of the patient at the time and the pitfalls of comparing one case with another. Consequently, it is not a test which will give indisputable evidence by itself. With proper caution in interpretation, however, it can be of great value, as has been pointed out, in corroborating, and giving additional information to, the encephalographic diagnosis. In the presence of suggestive findings, such as rather large ventricles and small cortical subarachnoid spaces, it may be advantageously correlated with the clinical findings to establish the diagnosis. In the presence of an apparent delayed rate of absorption, the ven-

practise These legal specifications, although they differ considerably in each State, have been important in forcing medical schools throughout the country to meet the accepted standards of education (2)

In the past, medical education has concerned itself almost exclusively with the training of physicians and contributions of discoveries regarding health and disease. The rapid growth in knowledge and the changes in social organization have greatly complicated the original problems of medical service (2). With the further production and perfection of various medical instruments and the advance of the physical sciences has come the development of specialism in medicine. In order to protect the public, the Council on Medical Education and Hospitals, of the American Medical Association, soon recognized that the resulting growth of specialism would have to be established upon a broad foundation of general medical training (3). In 1933, therefore, the House of Delegates authorized the Council to approve such special boards as should meet the specifications formulated by the Council. Working on this basis, the Council, in 1933-1934, organized an "Advisory Board for Medical Specialties," for the certification of medical specialists in the United States and Canada. In a comparatively short time, twelve certifying boards were created, and they have exerted a tremendous influence in improving both general and special medical education.

II INFLUENCE OF RADIOLOGIC SOCIETIES UPON MEDICAL EDUCATION

The American Roentgen Ray Society held its first meeting in New York, December 13 and 14, 1900. Since that time, the organization has grown, both in wisdom and numbers, until at the present time, it has 432 active members, most of whom are Fellows of the American Medical Association. The Society has one meeting annually and maintains the "American Journal of Roentgenology and Radium Therapy" as its official organ.

This Journal also publishes the papers presented at the annual meeting of the American Radium Society, organized in 1916. This Society has 135 active members, most of whom are, also, Fellows of the American Medical Association.

The Radiological Society of North America was organized in 1920. Its official organ is RADIOLOGY. The active membership list of this Society numbers 1,237, with most of the members also Fellows of the American Medical Association. One meeting is held yearly.

The American College of Radiology was organized in 1923. It is concerned largely with medical education and economics, 260 members are listed in its directory.

In 1924, the American Medical Association established a Section on Radiology. This Section holds its meeting at the time of the annual session of the Association. Its members participate in the scientific exhibit, as well as in the other activities and deliberations of organized medicine.

In addition to these major radiologic societies, there are 36 local radiologic societies distributed in 29 of the States, with six Sections on Radiology as component parts of different State medical societies. Each one of these organizations is assisting in an admirable way to elevate the standard of radiology. The members are pledged to the study of radiology as it pertains to medicine, to provide for meetings, and to disseminate information through published articles.

III INFLUENCE OF THE AMERICAN MEDICAL ASSOCIATION UPON RADIOLOGY THROUGH ITS COUNCIL ON MEDICAL EDUCATION AND HOSPITALS

Early in 1920, the specialty of radiology was invaded by lay practitioners and other unqualified individuals who set up "x-ray laboratories" to compete with the qualified radiologists. In order to overcome this and other evils, the American Medical Association was asked to provide for supervision and certification in the field of radiology. The House of Dele-

THE SITUATION OF RADIOLOGY IN MEDICAL EDUCATION IN THE UNITED STATES AND CANADA¹

By EUGENE P. PENDERGRASS, M.D., *Philadelphia*

From the Hospital of the University of Pennsylvania

RECENT medical literature frequently refers to the "advances of the last twenty-five or fifty years." Such periods of time cannot properly be applied to the progress of radiology. Its advancement must of necessity be measured by some shorter standard. In this country radiology is scarcely forty years old. Yet, in that brief period, our specialty has made stupendous strides. Skinner (1) aptly states that "no other field of human research has enjoyed such immediate and universal participation, such profound adaptability to problems of human disease, such extensive availability to the world's population, and such splendid benefit to unconquered fields of diagnosis and therapy as roentgen diagnosis and radiation therapy."

Although medicine, generally, has been passing through a very difficult period, a period in which economic problems and the socialization of medicine have been uppermost in the minds of those controlling the destiny of organized medicine, radiology has continued to advance. In like manner, during this same time, the scope of medical education has expanded considerably. Hospitals have improved their physical equipment, a closer relationship has sprung up between hospitals and medical schools, and an increasing number of institutions, by fulfilling the "Principles of Graduate Medical Schools," have earned the right to give graduate medical instruction. It seems advisable, therefore, that an organization such as the International Congress of Radiology should set aside a certain time for the consideration of the tremendous problem of education in radiology. For concomitant with

the development of this specialty, the use of radiologic methods in medical education has been swift.

With these thoughts in mind, our President has asked me to prepare for you a statement concerning the present status of radiology in medical education in the United States. It is our hope that the consideration of some of the facts connected with this problem will assist in the further development of an even closer relationship between radiology and the other branches of medicine and surgery, particularly in reference to the newer conceptions and methods of medical education. In order to discuss this subject in as systematic and comprehensive a manner as possible, we should like to review some of the influencing factors that have placed radiology in its present position in medical education and then take up the details of its instruction in undergraduate, graduate, and even more advanced courses.

I INFLUENCE OF THE AMERICAN MEDICAL ASSOCIATION UPON MEDICAL EDUCATION IN GENERAL

Medical education in the United States is regulated by rules and specifications of the American Medical Association, the Association of American Medical Colleges, and the various State requirements for licensure to practise (2). In 1900, statistics on the medical school situation were published by the American Medical Association, and in 1904, the Council on Medical Education was created. Since that time, the Council, through its annual conferences, inspections, and classification of medical schools, has formulated educational requirements which have promptly been embodied by the various States in their legal requirements for licensure to

¹ Presented at the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

ready access to radiologic equipment and service. When a full time or part time physician-roentgenologist cannot be employed, the services of such a consultant should be secured. Radiologic interpretations must be made only by a competent roentgenologist. A description of the roentgenologic examinations should be placed in the patient's chart. The physician-roentgenologist preferably should be one listed by the Council on Medical Education and Hospitals of the American Medical Association.¹

"The foregoing requirements are substantially in harmony with each other and consistent with the requirements of organized radiology. In the interests of uniformity and terminology, some changes are indicated, and such changes probably will be made soon. There is no doubt that the Council will advance its requirements for radiologic service in hospitals as rapidly as demanded by the interests of the public and consistent with the powers and limitations under which the Council works" (4).

V AMERICAN BOARD OF RADIOLOGY

In 1933, the American Board of Radiology was organized. "On December 9, 1935, the Council on Medical Education and Hospitals officially extended its recognition to this Board under the authority granted to the Council by the House of Delegates, henceforth, the list of diplomates of the American Board of Radiology will take the place of the Council's list of radiologists" (4). This recognition has been a most important one for radiology and has exerted a profound influence upon radiologic standards and education.

The Board of Radiology consists of fifteen radiologists selected from each of the radiologic societies. These men, with the Advisory Committee of the Council on Medical Education and Hospitals, have developed the following qualifications pertaining to education and special training.

"*Professional Education*—1 Graduation from a medical school of the United

States or Canada, recognized by the Council on Medical Education and Hospitals of the American Medical Association

"2 Completion of an internship of not less than one (1) year in a hospital approved by the same Council

"*Special Training*² (to be effective after Jan 1, 1938)—1 A period of study after the internship of not less than three (3) years in an institution or radiological department recognized by the Council and the Board as competent to provide satisfactory training in the field of radiology

2 "This period of special preparation shall include

"(a) Intensive graduate training in pathologic anatomy, radiophysics, and radiobiology

"(b) An active experience of not less than twenty-four (24) months in a radiological department recognized by the Board and Council as capable of providing satisfactory training

"(c) Examination in the basic sciences of radiology, as well as in the clinical aspects thereof"

"3 An additional period of not less than two (2) years of study and/or practice"

Since the organization of the Board of Radiology, 849 radiologists have been examined and certified. The members of this Board have given untiringly of their time and thought to the many problems that have confronted them. American radiology owes much to these men and their ceaseless efforts in its behalf.

VI THE PROGRAM OF THE AMERICAN COLLEGE OF RADIOLOGY IN THE FIELD OF EDUCATION

The fundamental objective of the American College of Radiology is the advancement of the science and practice of radiology to the highest possible plane. Probably the most important element in

² In the case of an applicant whose training has been received outside the United States and Canada the credentials must be satisfactory to the Advisory Board for Medical Specialties (5)

gates granted this assistance to radiology and assigned the task to the Council on Medical Education and Hospitals. The Council turned for help to the leading radiologists of the existing radiological societies. These radiologists formed an Advisory Committee and worked with the Council in setting down "Essentials for Admission to the List of Physicians Specializing in Radiology." "This committee was retained by the Council as a permanent one, and branch committees in every State were selected to pass upon the qualifications of those who applied for certification. The object was to provide the medical profession, hospitals, and the public with a list of men from which to make selection whenever the services of a radiologist were needed" (4). The regular, annual publication of this list since 1931 has proved itself a powerful educational force and a definite aid to radiology.

IV REQUIREMENTS OF THE COUNCIL ON MEDICAL EDUCATION CONCERNING RADIOLOGIC SERVICES IN HOSPITALS

"In the approval of hospitals for internships and residencies, and in surveying all hospitals for registration, the requirements for radiologic services are definitely outlined. The earliest official set of hospital requirements by the Council on Medical Education and Hospitals was its 'Essentials in a Hospital Approved for Training Interns,' first issued in 1914. It has ever since that time been circulated among hospitals and has been used as a basis of approving them. The early issues of the 'Essentials' stated that the hospital should have 'A roentgen-ray department in charge of an expert roentgenologist, and equipped to do roentgenographic fluoroscopic, and therapeutic work'.

"By 1925, this requirement was expanded to read as follows

"The roentgen-ray department shall be in charge of a roentgenologist whose attainments are at least equal to those of other staff members and who shall supervise and instruct interns in all essential phases of roentgenology. The depart-

ment must be equipped to do roentgenographic, fluoroscopic, and therapeutic work. The intern should receive instruction both in regard to the technic and dangers of roentgen-ray application and also in plate-reading, and in the therapeutic uses of the roentgen-ray'.

"This requirement has been administered as rigidly as feasible in all of the Council's inspections, correspondence, and dealings with those hospitals. The object was not to make the intern an expert in radiology, but to teach him how to make use of it in his subsequent practice of medicine. In recent years the requirement reads as follows

"This department must be equipped for at least roentgenographic and roentgenoscopic procedures and must be directed by a physician-roentgenologist who is properly qualified for the work which the department purports to do. Records of the work carried out must be on file in the department, and copies should be filed with the clinical charts'.

"With the establishment of 'Essentials in a Hospital Approved for Residencies in Specialties,' the Council has adopted the following requirements

"The roentgen-ray laboratory shall be under the direction of a qualified roentgenologist, proficient in the mechanical and interpretative functions of his specialty. He must likewise co-operate in all matters pertaining to the residencies which fall within the purview of his department. The department should contain roentgenologic, roentgenoscopic and, where required, therapeutic equipment.

"Residents in roentgenology or radiology should serve under a specialist who is eligible for inclusion in the list of qualified roentgenologists as prepared by the Council. The laboratory should contain complete diagnostic and therapeutic equipment'.

"The 'Essentials of a Registered Hospital,' established by the Council in 1928, say regarding the radiologic equipment and service in all registered hospitals

"The hospital should provide or have

DISTRICT OF COLUMBIA

Georgetown University School of Medicine Washington, D C In first year, two hours per week, Anatomy as shown by x ray, in second year, one hour per week, Physiological Processes as shown by x ray, in third year, two hours per week during one half year, 10 hours each section X ray Pathology, in fourth year, 15 hours Radiology Radiology is rated on a par with Medicine and Surgery as a separate department of which I O Cox M D Professor of Radiology, is head of Department

George Washington University School of Medicine, Washington, D C In third year, Radiology is an elective course one hour per week for 16 weeks (Radiology and Radiotherapy) It is rated on a par with other specialties, included in Department of Medicine, under W A Bloedorn, M D, Professor of Medicine

Howard University College of Medicine, Washington D C In third year, 22 hours instruction in Roentgenology In Department of Surgery, under an instructor in roentgenology

GEORGIA

University of Georgia School of Medicine, Augusta In fourth year 66 hours instruction in Radiology (See Bulletin, p 53) On a par with the other specialties L P Holmes, M D, Professor of Clinical Roentgenology, G T Bernard, M D Professor of Clinical Surgery and Dermatology (Radium Therapy), are in charge of Department

ILLINOIS

Loyola University School of Medicine, Chicago In first year, anatomical demonstrations by x ray, in second year, 12 hours, not including special demonstrations of x rays in Physiology in third year, 36 hours of lectures and lantern demonstrations and from 12 to 24 hours in small sections at various hospitals, in fourth year, from 4 to 12 hours to each section at various hospitals in correlation with Clinical Surgery, Diagnosis, and Out-patient Department Radiology is on a par with the other specialties Benjamin H Orndoff, M D, Professor of Radiology is in charge of Department

Northwestern University Medical School, Chicago In first year, from 40 to 44 hours (two hours per week for two quarters), Radiological Anatomy, in second year no set hours, but requested in Physiology and Pathology, in third year, 33 hours (one hour per week for three quarters), textbook, Radiological Didactics, in fourth year, 36 hours approximately, dispensary study of Radiology (See Bulletin pp 20 and 47) Radiology is on a par with the other specialties, a division of Department of Surgery James T Case M D, Professor of Radiology, is in charge of Division

University of Chicago, Rush Medical College Chicago In third year 33 hours in Surgery (and another course of 24 hours), and 26 hours in Pediatrics, in fourth year, two courses of 24 hours each in Surgery and 6 hours in Pediatrics Radiology is included in the Department of Surgery V C David, M D, Chairman, Department of Surgery, F H Squire, M D, Assistant Clinical Professor of Surgery (Radiology), are in charge

University of Chicago, The School of Medicine of the Division of the Biological Sciences, Chicago In third year, one and one half hours per week for one year (Roentgenology) seminar plus ward rounds and x ray viewing room, in fourth year 22 hours in Autumn quarter (Roentgenology), lectures plus continuation of third year work Radiology is on a par with Medicine and Surgery, technically in the Division of Medicine but practically separate. Paul C Hodges M D, Professor of Roentgenology, is in charge.

University of Illinois College of Medicine, Chicago In first year, approximately 16 hours as part of Anatomy, in second year, approximately four hours as part of Physiology, in third year, no time allotted but in near future will be incorporated with Pathology, in fourth year, 32 hours didactic work, with slide demonstrations (16 hours), each semester An optional course is offered in film interpretation (12 hours), dispensary practice, with technic, diagnosis, and therapy Radiology is on a par with the other specialties Separate department, of which Adolph Hartung M D, Professor of Roentgenology, is head.

INDIANA

Indiana University School of Medicine, Bloomington and Indianapolis In first year normal radiographs of bony parts are shown in Osteology and Anatomy, in third year, clinical and dispensary work, clinical conferences, in fourth year, roentgen diagnosis and radiotherapy Radiology is included in Division of Medicine. R C Beeler, M D, Professor of Radiology is in charge of Division

IOWA

State University of Iowa College of Medicine, Iowa City In first year, stock films are used in Anatomy to demonstrate bone relations, in second year, one demonstration of normal flow of barium through the gastro-intestinal tract, in third year, 32 hours, two semesters, roentgen interpretation, lectures, and slides, in fourth year, 16 hours in second semester (as elective) Roentgen Interpretation, also six lectures on therapy (See Bulletin, pp 305, 306) Radiology is in the Division of Medicine probably classed as one of the specialties H D Kerr M D, Professor of Radiology is in charge of Department

KANSAS

University of Kansas School of Medicine Lawrence, Kans, and Kansas City Kans In third year 18

gates granted this assistance to radiology and assigned the task to the Council on Medical Education and Hospitals. The Council turned for help to the leading radiologists of the existing radiological societies. These radiologists formed an Advisory Committee and worked with the Council in setting down "Essentials for Admission to the List of Physicians Specializing in Radiology." "This committee was retained by the Council as a permanent one, and branch committees in every State were selected to pass upon the qualifications of those who applied for certification. The object was to provide the medical profession, hospitals, and the public with a list of men from which to make selection whenever the services of a radiologist were needed" (4). The regular, annual publication of this list since 1931 has proved itself a powerful educational force and a definite aid to radiology.

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"This department must be equipped for at least roentgenographic and roentgenoscopic procedures and must be directed by a physician-roentgenologist who is properly qualified for the work which the department purports to do. Records of the work carried out must be on file in the department, and copies should be filed with the clinical charts'.

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"The roentgen-ray laboratory shall be under the direction of a qualified roentgenologist, proficient in the mechanical and interpretative functions of his specialty. He must likewise co-operate in all matters pertaining to the residencies which fall within the purview of his department. The department should contain roentgenologic, roentgenoscopic and, where required, therapeutic equipment.

"Residents in roentgenology or radiology should serve under a specialist who is eligible for inclusion in the list of qualified roentgenologists as prepared by the Council. The laboratory should contain complete diagnostic and therapeutic equipment'.

"The 'Essentials of a Registered Hospital,' established by the Council in 1928, say regarding the radiologic equipment and service in all registered hospitals:

"The hospital should provide or have

in separate department Leo G. Rigler, M.D., Professor of Radiology, is head

MISSOURI

St. Louis University Medical School, St. Louis, Mo. In first year, fluoroscopic demonstrations to classes in Anatomy, in second year, demonstrations in association with lectures on Physiology, in third year 32 didactic lectures and demonstrations of one and one-half hours each, in fourth year, individual sections on Clinical Roentgenology, one-hour lecture and demonstration each week throughout school year. Radiology is rated on a par with the other medical specialties, in separate department I. R. Santa, M.D., Professor of Radiology, is head.

Washington University School of Medicine, St. Louis, Mo. In fourth year, four hours per week for three semesters. Radiology (elective). Radiology is rated on a par with other specialties, in separate department Sherwood Moore, M.D., Professor of Radiology, is head.

NEBRASKA

Creighton University School of Medicine, Omaha, Nebraska. In first year, 10 hours Anatomy and Physiology, in second year, 11 hours lectures, demonstrations and conferences. X-ray Fundamentals, in third year, 22 hours lectures, demonstrations, and conferences, one hour per week for year (dispensary, in sections) Principles and Practice of Radiation and Physical Therapy, one hour per week to sections for one year (11 hours to each section), practice work in the hospital and dispensary, Radiological Methods of Examination. Radiology is rated on a par with other specialties, included in Department of Surgery J. F. Kelly, M.D., Professor of Radiology and Physiotherapy, is in charge.

University of Nebraska College of Medicine, Omaha. In second year, 16 lectures (one-half hour credit) Principles of Radiology, in third year four ward rounds therapy section, 18 conferences (one-half hour credit) Clinical Radiology, in fourth year, occasional (elective) instruction, eight lectures and demonstrations (one hour credit) Roentgen Technique. Radiology is rated on a par with other specialties, separate department H. B. Hunt, M.D., Associate Professor of Radiology (to be Professor next year), is in charge.

NEW HAMPSHIRE

Dartmouth Medical School, Hanover. In first year Radiology is used in teaching Anatomy and Physiology, in second year, in teaching Diagnosis and Surgery. Radiology exists as a docentship L. K. Sycamore, M.D., Docent in Roentgenology is in charge.

NEW YORK

Albany Medical College, Albany. In third year, 16 hours to whole class, 15 hours to each one-sixth. Roentgenology, in fourth year, instruction in con-

junction with medical and surgical clinics and in Physical Diagnosis. Radiology is on a par with other specialties, included in Department of Surgery W. P. Howard, M.D., Clinical Professor of Roentgenology, is in charge.

Long Island College of Medicine, Brooklyn. In first year, 10 hours with Anatomy, in second year, four hours with Physiology, in third year, no specific hours, in conjunction with Medicine, Surgery, and Pediatrics, in fourth year, 60 hours. Radiology is rated on a par with other specialties, included in Department of Medicine, under the professor of Clinical Radiology.

Cornell University Medical College, Ithaca and New York City. In third year, eight hours Radiology, in fourth year, free time may be spent on the subject. Radiology is not rated with the other specialties, separate department H. M. Imboden, M.D., Professor of Clinical Radiology, is head.

Columbia University College of Physicians and Surgeons, New York City. In first year, films being assembled to teach Anatomy, in third year, 25 hours for demonstrations of malformations in informal section in X-ray Department, in fourth year, 16 hours to groups of 12, two lectures on Radiotherapy, film reading (See Bulletin, p. 61). Radiology is rated on a par with other specialties, separate department Ross Golden, M.D., Professor of Radiology, is head.

New York Medical College and Flower Hospital, New York City. In first year, 12 hours in conjunction with Anatomy, Roentgenology, normal bone and viscera demonstrations, in second year, 12 hours Roentgenology, demonstrations of pathologic conditions, in third year, 12 hours X-ray and Radium Therapy, in fourth year, 12 hours to each student (instruction given in sections), clinical demonstrations of radiologic conditions. Radiology is rated equal with other specialties, separate department J. Campbell Howard, M.D., Professor of Radiology, is head.

New York University College of Medicine, New York City. In first year, 10 hours lectures, 10 hours section work per student in X-ray Anatomy, in second year, three hours lectures, three hours section work per student in X-ray Physiology, 10 hours lectures on Pathologic Basis of X-ray Diagnoses, two elective courses (one month 20 lessons) in Normal Anatomy Variations and Congenital Malformations, Physics of Radiology, in third year, 16 hours practical demonstrations to each student of X-ray Diagnosis, five hours lectures on Radiation Therapy, in fourth year, two elective courses (six hours per week for four weeks) in General X-ray Diagnosis, an elective course on Gastro-intestinal Tract an elective course on Bones and an elective course on Thorax. Radiology

such a program is education. The College has, therefore, appointed a Commission on Education, whose function is to prepare and present for consideration suggestions relating to medical education. These presentations are made at the regular annual meeting of the College, which is held in Chicago in February. Prepared manuscripts have been given by leaders in medical education at several such meetings.

Under the auspices of the College, an Annual Conference of Teachers in Clinical Radiology was organized at Kansas City, Missouri, May 14, 1936. It is hoped that this yearly conference will stimulate a more active interchange of ideas and lead to the improvement of teaching in radiology in medical schools.

VII RADIOLOGY IN UNDERGRADUATE MEDICAL EDUCATION

In an effort to obtain concrete data on this subject, questionnaires, requesting certain information, were mailed to every Class A medical institution in the United States and Canada. The following tabulation gives in detail the data collected. The schools that did not return their questionnaires had to be omitted.

STATISTICS AS REGARDS RADIOLOGY IN RECOGNIZED MEDICAL SCHOOLS IN THE UNITED STATES AND CANADA

ALABAMA

University of Alabama School of Medicine, Tuscaloosa. Two-year course only. Prof J A Maxwell, M D, gives two sessions in second year of Anatomy to introduce Radiology.

ARKANSAS

University of Arkansas School of Medicine, Little Rock. In third year, 11 hours of General Roentgenology, in fourth year 22 hours of Clinical Roentgenology. Radiology is rated with other medical specialties. It is included in the Division of Medicine and Medical Specialties. D A Rhinehart, M D, is Professor of Roentgenology. Barton A Rhinehart, M D, is Associate Professor.

CALIFORNIA

University of California Medical School, Berkeley and San Francisco. In first year, 10 lectures on Radiology as applied to the teaching of Anatomy, in second year one hour per week with Pathology for one semester, or 15 hours, in third year, eight lectures as part of General Surgery, eight informal confer-

ences and discussions with Surgery, study of x-rays of own medical patients, in fourth year, two hours per week for ten and two-thirds weeks during General Surgery assignment, also x ray study of own patients. Radiology is rated on a par with specialties, a sub-department of Surgery. Howard E Ruggles, M D, Clinical Professor of Roentgenology is head of Sub-department.

University of Southern California School of Medicine, Los Angeles

In first year, six hours demonstration of x-ray films in connection with Anatomy, in second year, 12 hours fluoroscopic examination of gastrointestinal tract in Physiology and of chest in Physical Diagnosis, study of films with patients in groups of 24, in third year, from 43 to 50 lectures, demonstrations, and conferences, in fourth year, no formal course other than viewing films of out-patient department (12 hours). Radiology serves all departments and can hardly be compared to other specialties. It is included in the Department of Medicine. Ray A Carter, M D, Associate Professor of Clinical Medicine, is in charge.

Stanford University School of Medicine, San Francisco

In first year, the x ray is used a little in teaching Anatomy and Physiology, in second year, 10 hours (Medicine 203), Radiology Physics of Radiation, in third year, 33 hours (Medicine 213) clinical radiological conferences in fourth year, 44 hours required, 41 hours elective (Medicine 213, Medicine 3—Radiology, Medicine 4—Fluoroscopy, Medicine 12—Advanced Radiology, Surgery 211—Tumor Clinic, Pathology 3—Oncology) (Information derived from letter). Radiology is rated on a par with the specialties, included in Department of Medicine. R. R. Newell, M D, Professor of Medicine, is in charge.

COLORADO

University of Colorado School of Medicine, Denver

In first year films are used in teaching Gross Anatomy, in second year, Radiology is incidental to Medicine and Surgery. In third year, 31 hours are devoted to Roentgenology, in fourth year, 31 hours (elective) are devoted to Roentgenology. It is rated with the Division of Surgery, and Ernst A Schmidt, M D, Associate Professor of Surgery, is in charge of Radiology.

CONNECTICUT

Yale University School of Medicine, New Haven

In first and second years, no Radiology is taught, in third year, an introductory course is required (small groups one-half trimester, one hour per week for five and one half weeks, Clinical Medicine 110, Radiology), in fourth year, elective, groups limited to six students, two hours, three times per week, for five and one half weeks, Radiology 120 (See Bulletin, pp 106 and 113). Sect of Radiology, Div of Surgery. W H Wilson, M D, Assistant Professor of Radiology.

University of Pennsylvania School of Medicine, Philadelphia In first year, instruction in Radiology is included in Anatomy and Physiology, in second year, included in Pathology, in third year, 16 hours to entire class didactic elementary course in Radiology, in fourth year, 40 hours in small groups conferences, round table discussions, and ward classes. Radiology is rated on a par with other specialties, separate department, of which H K Pancoast, M D, Professor of Radiology, and E P Pendergrass, M D, Professor of Radiology are heads

Woman's Medical College of Pennsylvania, Philadelphia In first year, 24 hours demonstrations relating to anatomy, in second year, six hours Roentgenologic Technic and appearances of limbs and viscera, in fourth year, 14 hours lectures and demonstrations in Roentgenology. Radiology is not rated on a par with other specialties and fewer hours are devoted to it. Separate department, of which Jacob Vastine, M D, Clinical Professor of Radiology is head

University of Pittsburgh School of Medicine, Pittsburgh In third year, eight hours Roentgenology, in fourth year, 31 hours Roentgenology. Radiology is rated on a par with other specialties. Separate department, of which G W Grier, M D, Professor of Radiology is head

SOUTH CAROLINA

Medical College of the State of South Carolina, Charleston In first year, demonstrations of normal anatomy in conjunction with Anatomy. In second year demonstrations in conjunction with Pathology. In third year, 32 lectures and demonstrations on Radiology and Electrotherapy (elective course), in fourth year, films, fluoroscopic examinations and treatment demonstrations. Radiology is rated on a par with Dermatology, Otolaryngology, etc., sub-department of Medicine. Hilmyer Rudisill, Jr, M D, Professor of Radiology and Electrotherapy, is in charge

SOUTH DAKOTA

University of South Dakota School of Medicine, Vermillion Only two-year medical course given

TENNESSEE

University of Tennessee College of Medicine, Memphis In second year, 22 hours Roentgenology (401), in third year, included in various courses, in fourth year, 22 to 33 hours Roentgenology (602). Radiology is rated on a par with other specialties, separate department, of which W S Lawrence, M D, Professor of Roentgenology, is head

Meharry Medical College, Nashville In first year, eight hours Osteology, in fourth year, 32 hours didactic work and clinics in groups, two hours per week, Roentgenology. Radiology is rated as a

lecture course, included in Department of Medicine. H S Shoulders, M D, Professor of Roentgenology is in charge

Vanderbilt University School of Medicine, Nashville In third year, 26 hours Roentgenology, in fourth year, 13 hours Radiology, 90 hours Roentgen Diagnosis 26 hours X ray Technic (See Bulletin, p 118). Radiology is rated on a par with Medicine and Surgery, separate department, of which C C McClure, M D, Associate Professor of Radiology, is head

TEXAS

Baylor University College of Medicine, Dallas In fourth year, 30 hours, Diagnosis, 30 hours Tumor Clinic, Radiology-Tumor Clinic. Radiology receives ample recognition, included as part of Surgical Department but really independent. J M Martin, M D, Professor of Radiology, and C L Martin, M D, Professor of Radiology, are co-equally in charge

University of Texas School of Medicine, Galveston In first year, Radiology is employed in the study of bones, the thorax and gastro-intestinal tract in conjunction with Anatomy, in third year, one lecture per week for 14 weeks. Radiology in fourth year, one lecture per week for 14 weeks, combined with demonstration, Radiology (See Bulletin pp 48, 49). Radiology is rated as a minor subject on a par with medical specialties. Separate department of which J B Johnson, M D, Associate Professor of Radiology, is head

UTAH

University of Utah School of Medicine, Salt Lake City In second year, 12 hours X ray Anatomy. Two-year medical course only

VERMONT

University of Vermont College of Medicine, Burlington In second year, six hours Roentgenology (four hours in Pathology on Tumor Therapy), in third year, six hours Roentgenology, in fourth year, 10 hours Roentgenology. Radiology is rated among the minor specialties. A separate department, but much teaching in conjunction with Departments of Medicine, Surgery, and Pathology. A B Soule, Jr, M D, Instructor in Roentgenology is in charge

VIRGINIA

University of Virginia Department of Medicine, Charlottesville In first year occasional lectures and demonstrations in Anatomy, in second year, no special hours but demonstrations of clinical cases in Physical Diagnosis. In third year, demonstrations in connection with clinical cases. In fourth year, 20 hours didactic course, Roentgenology. Radiology is rated essentially on a par with major departments. Separate department, of which Vincent Archer, M D, Professor of Roentgenology is head

hours of didactic elementary roentgenology and eight hours of clinical work in groups of 8, in fourth year, 22 hours of clinical work, 22 hours (elective) clinical roentgenology as applied to medicine, diagnostic and clinical roentgenology, and the practice of roentgenology. Radiology is on a par with the other specialties in the Division of Medicine. G M Tice, M D, Assistant Professor of Radiology, is in charge of Department.

KENTUCKY

University of Louisville School of Medicine, Louisville
In first year, fluoroscopic demonstrations of chest and abdomen by professor of anatomy, in second year, fluoroscopic examinations and demonstrations of chest and abdomen and use of barium meal before small groups, in third year, 24 hours didactic lectures on Radiology, with lantern slides, in fourth year, 18 hours radiation therapy, with applications, and ward rounds of cancer patients. Radiology is a branch of the Division of Surgery. D Y Keith, M D, Instructor in Radiology, is in charge.

LOUISIANA

Louisiana State University Medical Center, New Orleans
In fourth year, 14 hours of instruction in Radiology. On a par with the other specialties, in Division of Surgery. Amédée Granger, M D, Professor of Radiology, is in charge.

Tulane University of Louisiana School of Medicine, New Orleans
In second year, general lectures with Pathology and Medicine, in third year, 19 hours to a group which rotates in Diagnostic Roentgenology, in fourth year, eight hours to a group which rotates in Radiation Therapy. Six general lectures. Radiology to combined third- and fourth year classes, radiological conferences each morning for one hour to third- and fourth year classes, graduate teaching in Radiology formerly given in post graduate school now given in undergraduate school. Radiology is on a par with other specialties, in Department of Medicine. Leon J Menville, M D, Professor of Radiology, is in charge.

MARYLAND

University of Maryland School of Medicine and College of Physicians and Surgeons, Baltimore
In fourth year, two hours instruction per week in Roentgenology (See Bulletin, p 49). Radiology is on a par with other specialties in Sub-department of Surgery. H J Walton, M D, Professor of Roentgenology is in charge.

MASSACHUSETTS

Boston University School of Medicine, Boston
In first year, five hours of clinical correlation exercises, in third year 16 hours Roentgenology (elective), five hours clinical correlation. 28 hours x ray conferences, in fourth year 18 hours Clinical Radiology. Radiology is a specialty under Department of Surgery. The assistant professor of roentgenology is in charge.

Harvard University Medical School, Boston
In first year, one hour lecture-demonstration to explain purpose and value, routine chest films with tuberculin test of first- and fourth-year students, in third year, 12 hours, in groups of 16 students (not a separate course), in fourth year, one month, all day (elective), Medicine IX. One-third of class of 125 take the course. Clinical conferences, x-ray seminar, etc. Radiology is under the Department of Medicine but is not rated on a par with other specialties. George W Holmes, M D, Clinical Professor of Roentgenology, is in charge.

Tufts College Medical School, Boston
In second year, 15 hours clinical lectures in Radiology, in third year, 16 hours of roentgen interpretation, in fourth year, one month daily (elective) in one of three hospital radiological departments. Radiology is held to be independent of, but correlated to, Departments of Medicine and Surgery. F W O'Brien, M D, Professor of Radiology, is head.

MICHIGAN

University of Michigan Medical School, Ann Arbor
In first year, no specific number of hours is allotted to Radiology, studied as an adjunct to Anatomy, in second year, 16 hours (elective), No 120, introduction to Roentgenology and Physical Therapy, in third year, 32 hours, No 130, Principles of Roentgenology and Physical Therapy, also 32 hours, No 131, Junior section in Clinical Roentgenology and Radiation Therapy, in fourth year, approximately 32 hours, adjunct to other clinical subjects (See Bulletin, pp 95, 96). Radiology is rated on a par with Medicine and Surgery, separate department. F J Hodges, M D, Professor of Roentgenology is head.

Wayne University College of Medicine, Detroit
In first year, in conjunction with Anatomy, five to ten hours demonstration of normal films (not a separate course), in second year, five to ten hours in conjunction with Physiology, in third year, one hour per week for twelve weeks of lectures and demonstrations, in fourth year, three hours per week for twelve weeks of lectures and clinical work. Radiology is rated on a par with other specialties, in the Division of Medicine. J C Kenning, M D, Professor of Roentgenology, is in charge.

MINNEAPOLIS

University of Minnesota Medical School, Minneapolis
In first year, four hours lectures and demonstrations to sections (elective) on Roentgenology of Normal Anatomy. In second year 11 hours on Biophysics, in third year, 33 hours lectures (elective) on Radiology including diagnosis and therapy, in fourth year, 11 hours lectures, three hours per week demonstrations and clinics in Roentgen Diagnosis. Radiology is rated on a par with Medicine and Surgery,

teaching of preclinical courses. All schools agreed, generally, that radiology should be presented to the undergraduate with the idea of making a good general practitioner and not a specialist. Since radiology serves every branch of medicine and almost every research problem, the student should, necessarily, have some understanding of normal and pathologic processes as they appear in the roentgenogram. Furthermore, irradiation, either by roentgen or radium therapy, is used so extensively in the treatment of neoplastic disease and certain infections that a physician is tremendously handicapped if he cannot intelligently approach such a consideration with his patient.

Anatomy—The majority of the four-year medical schools are using roentgenograms and fluoroscopic observations in connection with the teaching of anatomy, although very few two-year schools follow this method. Unfortunately, the information available at this time is insufficient to permit one to present a comprehensive outline of the methods used. Some schools give in excess of fifty hours of anatomy as revealed by radiologic methods, others, only one or two lectures and several fluoroscopic examinations. Demonstrations include osseous and epiphyseal development, movement of joints, roentgenograms of soft tissues, the injected arterial and venous circulation, the cerebrospinal fluid pathways after replacement of the fluid by air, the genital organs in the female after injection with opaque oils, the urinary and biliary tracts after the use of dyes to render their lumens visible, and the respiratory and gastro-intestinal systems. Fluoroscopic examinations include observations of joint movements and the respiratory and gastro-intestinal tracts. In some institutions, all the radiologic work is done by the instructors in anatomy, in others, assistance is given by the radiologists. When radiologic observations are correlated with dissection, the course becomes one that can properly be termed "living anatomy or physiology."

Physiology—Very few schools use roent-

gen methods as an adjunct in teaching physiology. Two schools devoted one hour per week throughout the year. With small groups, fluoroscopic consideration is given to the physiology of the respiratory and the gastro-intestinal tracts, and the cardio-vascular system. Roentgenograms, made after the administration of dye, are used in the demonstration of the physiology of the biliary and urinary tracts.

Several schools give a course in biophysics, which, in at least one instance, is allocated fifteen hours for the microscopic study of the effect of radiation on tissues.

Pathology—A great many schools have courses that are variously designated "X-ray Pathology," "Pathology, as Seen in the Roentgenogram," etc. Quite a few schools using radiologic methods in teaching anatomy do not use it in teaching pathology, and *vice versa*. At least one institution has an excellent x-ray museum, which is available for teaching anatomy, physiology, and pathology to small groups.

Physical Diagnosis—Relatively few institutions use either roentgenograms or fluoroscopic observations to teach their students physical diagnosis. It seems to me that, if radiologic methods were properly applied, it would assist in stimulating the student to improve his inspection, percussion, palpation, and auscultation. I feel there is a real opportunity here to foster the student's ability. You, as I, have doubtless marveled at the skill of those clinicians who have trained their eyes, ears, and palpating fingers to such an extent that their reports are usually confirmed, rather than made, by the appropriate roentgen examination. Such precision was obtainable, formerly, only by careful correlation of the physical findings with those of either operative or postmortem examinations. At the present time, unfortunately, there seems to be an increasing tendency to depend entirely upon the roentgen examination for diagnosis, instead of using it as a check and improvement of other diagnostic methods.

Clinical Radiology—Radiology is taught during the third and fourth years in almost

is a special department I Seth Hirsch, M D , Professor of Radiology is in charge

University of Rochester School of Medicine, Rochester In first year, demonstration of films of bony structures and circulation, in second year, eight hours demonstration of gastro-intestinal tract and heart, fluoroscopy of chest to check physical diagnosis, in third year, one hour per week for year of formal instruction in interpretation of films in fourth year, one hour per week throughout year of formal instruction Radiology is rated on a par with Dermatology but has a larger budget, included in Department of Medicine. S L Warren, M D , Associate Professor of Medicine, in charge of Division of Radiology

Syracuse University College of Medicine, Syracuse In third year, one hour per week during first semester Radiology in fourth year, one hour per week during entire year, Radiology and radiologic conferences Radiology is rated on a par with Medicine and Surgery, special department. Donald S Childs, M D , Professor of Clinical Radiology, is head Radiology is not taught as a separate science but in relation to and use in diagnosis and treatment

NORTH CAROLINA

University of North Carolina School of Medicine Chapel Hill This is a two-year school

Duke University School of Medicine Durham In first year, x ray skeleton in Department of Anatomy, in second year, eight hours each quarter principles of X ray Diagnosis in third year consultation on clinical cases, in fourth year 48 hours lectures, 72 hours tumor clinics Roentgen Diagnosis Radiology is rated on a par with Medicine and Surgery, separate department R J Reeves, M D Professor of Radiology is head

NORTH DAKOTA

University of North Dakota School of Medicine, Grand Forks This is a two-year school no department

OHIO

University of Cincinnati College of Medicine, Cincinnati In first year one hour per week during one semester Radiology eight hours Anatomy in second year, one hour per week during one semester Radiology with Pathology and Physiology (eight hours) in third year, one hour per week during one semester (one fourth of class in each section) interpretation of films (eight hours) in fourth year one hour per week during one semester (elective) General Radiology (16 hours) (See Bulletin pp 41-44 56) Radiology is rated on a par with other specialties separate department Sidney Lange M D , Professor of Radiology and Radiotherapeutics is head

Western Reserve University School of Medicine, Cleveland In third year 16 hours Roentgenology in

fourth year four hours in groups and four weeks in optional clerkship in Roentgenology Radiology is rated on a par with other specialties, included with Pathology Eugene Freedman, M D , Assistant Professor of Roentgenology, is in charge

Ohio State University College of Medicine, Columbus In fourth year, six hours X-ray Physics and Therapy Radiology is not rated on a par with other specialties, included in Department of Surgery H J Means, M D , Associate Professor of Surgery instructs in Roentgenology

OKLAHOMA

University of Oklahoma School of Medicine, Oklahoma City In first year, Radiology is taught in conjunction with Anatomy and Physics, in second year, in conjunction with Physical Diagnosis, in third year, x-ray instruction in out-patient department of hospital, in fourth year, 16 hours lectures and demonstrations in Diagnostic Roentgenology, 16 hours lectures and demonstrations in Therapeutic Radiology, practical demonstrations in Cardiology, Gastro-intestinal Examination, Urology and (elective) Orthopedics (Bulletin contains no outline of course.) Radiology is rated on a par with other specialties, separate department The professor of radiology is the head of the department

PENNSYLVANIA

Hahnemann Medical College and Hospital of Philadelphia In first year, no instruction in Radiology except in General Physics, in third year 30 hours didactic instruction, 10 hours Clinical Roentgenology, in fourth year five hours in sectional conferences Radiology is a separate section under Materia Medica and Therapeutics J W Frank, M D Professor of Roentgenology, is in charge

Jefferson Medical College of Philadelphia In first year two hours in Anatomy, in second year, one hour per week during whole term Roentgenology (six hours) in third year one hour per week after Christmas (20 hours) Roentgen Diagnosis and Therapy Radiology is considered as a specialty, separate department W F Manges, M D , deceased was head of the department

Temple University School of Medicine, Philadelphia In first year 50 hours Anatomy as Revealed by Roentgen Ray, in second year, four to five hours Physiology as Revealed by Roentgen Ray and Physical Diagnoses Checked by Roentgen Ray in third year, 20 hours Pathology as Revealed by Roentgen Ray, in fourth year, 40 hours clinical radiological conferences (clinical radiological sections of six students, five hours) Radiology is rated on a par with Medicine, Surgery, Anatomy, etc., but undergraduate courses in Radiology are minors Separate department, of which W E Chamberlain, M D , Professor of Radiology is the head

is, in many ways, a distinct asset. No one knows, at present, just how many institutions can fulfill the regulations of the Council on Medical Education. Likewise, the Council, itself, in setting up the specifications for Graduate Education, has placed a broad interpretation upon its requirements, since there are very few teachers who agree as to the precise methods and subjects to be taught. It will necessitate many years of careful thought, experience, and interchange of ideas before an ideal can be formulated.

Kirklin (5), Secretary of the American Board of Radiology, feels that judicious selection of the graduate students is of prime importance. It is his belief that the minimum three years of the course should be apportioned as follows:

"Six (6) months to pathologic anatomy, three (3) months to roentgenologic technique, twelve (12) months to roentgenologic diagnosis, and nine (9) months to radiotherapy, leaving six (6) months for the student to allot at will to any branch in which he is particularly interested or feels that he is deficient. If the course is arranged on the quarter system and students are admitted at the beginning of any quarter, the order in which the different branches are taken up may vary. However, special instruction in pathologic anatomy is so fundamentally essential for rational diagnosis and treatment that it should be given as early as possible.

"During his intensive review of pathologic anatomy, the student should have an opportunity not only to study the gross and microscopic pathology of specimens obtained at operation or necropsy, but also to compare the morbid conditions with the antecedent roentgenologic manifestations, and to observe at first-hand the effects of irradiation on normal and abnormal tissues. Occasionally it is desirable to subject cadavers to roentgenography before necropsy, and the necessary equipment should be available for this purpose. Roentgenography of removed specimens also is sometimes instructive. While the student is pursuing his studies in morbid anatomy, he should be encouraged to investigate some special radiopathologic problem as a theme for research.

"Instruction in roentgenologic diagnosis should begin with an active apprenticeship of three (3) months in the technic of roentgenography and the development of roentgeno-

grams. No matter how many technicians the practising radiologist may have to perform these duties for him, he will be gravely handicapped if he has not learned how to execute them himself. Not less than twelve (12) months of close observation and experience in roentgenologic diagnosis should be required. This service, of course, should comprise roentgenographic and roentgenoscopic interpretation in practically all anatomic and pathologic fields, both general and special. As soon as the student is familiar with the groundwork of diagnosis, he should be invited to make tentative interpretations and give his reasons therefor. The question, 'Why?' often repeated, is an effective spur to straight, clear thinking. Sometimes, I purposely entice the student into making a misinterpretation, in order to arouse a debate that may be more impressive than unquestioned statements. Constantly, the student ought to be stimulated to exercise his reason as well as his memory, to think in terms of morbid anatomy rather than the trite nomenclature of disease, and to draw conclusions either inductively or deductively, but always logically. He should be encouraged to compare roentgenologic diagnoses with the findings at operation and should have opportunities to visit the operating rooms in order to make such comparisons, or to observe or participate in procedures required for ventriculography, salpingography, and roentgenoscopy of the kidney at operation, or other roentgenoscopically controlled interventions. As a further stimulus, some phase of roentgen diagnosis should be assigned to the student for statistical analysis or research, and if the results are noteworthy, they may be given publicity in a joint paper by the student and one of his instructors. Any student who shows an aptitude for research, either in diagnosis or therapy, should have the co-operation of his instructors and should be granted a reasonable amount of time to carry on his investigations in the experimental laboratories of the institution. I feel, however, that student research should not be fostered at the expense of a well rounded training in clinical radiology.

The nine (9) months' training in therapy should include both roentgen and radium therapy, with thoroughly practical instruction in methods of measuring dosage, technics of treatment, and the selection of technics appropriate for various lesions in various situations. Further, this training should not be confined to methods preferred by the instructor, and the student should be given a fair and impartial insight into methods in vogue elsewhere.

"At institutions where the student is permitted to apply the last six (6) months of his

Medical College of Virginia, Richmond In first year, film demonstrations in Anatomy (Anatomy I), in second year, film demonstrations in Pathology (Pathology I), in third year, 16 hours first half-year, 16 hours in sections second half-year (Radiology I and II) Radiology is rated on a par with other specialties Professional equality on faculty and hospital boards with Medicine and Surgery Separate department, of which F B Mandeville M D, Professor of Radiology, is head

WEST VIRGINIA

West Virginia University School of Medicine Morgantown In first year, instruction is occasionally given in connection with Anatomy This is a two-year school.

WISCONSIN

University of Wisconsin Medical School Madison In third year, 16 hours Radiography and Radiotherapy, in fourth year four one-half day periods Applied Radiology Radiology is rated on a par with other specialties Separate department, of which E A Pohle M D Ph D Professor of Radiology, Chairman of Department of Radiology and Physical Therapy, is head

Marquette University School of Medicine, Milwaukee In first year 30 hours as part of Gross Anatomy in second year 30 hours as part of Living Anatomy and Pathology, in third year, 15 hours Roentgenology, in fourth year 16 hours Roentgenology (See Bulletin pp 53-54) Radiology is rated on a par with other specialties Separate division under Surgery F W Mackoy M D Clinical Professor and Director of Division of Roentgenology is in charge

CANADA

Dalhousie University Faculty of Medicine Halifax, N S In third year 30 hours Radiology Radiology is not rated on par with Medicine Surgery or specialties Separate department of which S R Johnston M B, Lecturer is in charge

University of Western Ontario Medical School London Ont In fifth year 30 hours in sixth year 15 hours extra demonstrations Department of Radiology (See Bulletin p 50) Radiology is rated on a par with all other departments Separate department, of which George McNeill M B Professor of Radiology is head This school has a six year medical course

University of Toronto Faculty of Medicine Toronto Ont In second year Radiology is taught as part of Anatomy in fifth year 10 hours each trimester, in sixth year 20 hours each trimester (See Bulletin pp 39, 40 and 50) Radiology is not actually on a par with Medicine and Surgery but is outwardly Separate department of which G E Richards M B

Professor of Radiology, is head This school has a six-year medical course

McGill University Faculty of Medicine, Montreal, Que In fifth year, instruction in Radiology is given Radiology is not on a par with other specialties It is not a separate department, a lecturer gives instructions This school has a six-year medical course

University of Montreal Faculty of Medicine, Montreal, Que In first year, 15 hours fundamental principles, 30 hours practical work in Radiology, in second year, 15 hours more advanced theoretical lectures in Radiology in third year, 10 hours Radiodiagnosis and Radiotherapy, in fourth year, 10 hours Radiodiagnosis and Radiotherapy Radiology is rated on a par with Medicine and Surgery Separate department, of which J E Gendreau M B, is Titular Professor

True to my expectations, there is a wide variation in the amount of time allocated to radiology, to its utilization in teaching such subjects as anatomy, physiology, pathology, and physical diagnosis, and also in clinical conferences It has seemed to me, however, as I have read and studied the data, that such a variance is a particularly stimulating situation, especially if the College of Radiology continues to sponsor the Annual Conference of Teachers of Radiology so that all may benefit by an exchange of ideas Since there is such a tremendous difference in the methods of teaching a preclinical subject, anatomy, for example, and the clinical subjects of medicine and surgery, it is small wonder that radiologists are often at a loss as to just how their specialty should be taught It was necessary to read only a few of the letters accompanying the answers to our questionnaire to find many real problems These varied from lack of an adequate budget and personnel to allocation of sufficient time in an already overcrowded curriculum Some teachers, in schools where considerable time is devoted to radiology, very properly raised the question as to whether the student may be failing to develop other diagnostic methods Others, in schools where little recognition has been given to radiological methods in the past, felt an increasing need for such methods in the

Technic

- Demonstration of x ray apparatus, position of patient for roentgen examination of various parts, positions for therapy 26 G W Chamberlin, M D

Clinical Medicine

- Gastro enterology, lecture and clinical demonstration 15 H L Bockus M D
- Gastro enterologic patient presented in conference with gastro enterologist and surgeon 30 H L Bockus M D
W E Lee, M D
- Anatomy, diagnosis surgery and treatment of neurologic conditions 30 O V Batson, M D
F C Grant, M D
N W Winkelman, M D
B J Alpers M D
W Drayton, Jr M D
F H Leavitt, M D
J C Yaskin, M D
- Syphilology, general and special lectures on diagnosis and treatment 22 F D Weidman, M D
S S Greenbaum, M D
W H Mackinney, M D
L C Peter, M D
J H Stokes, M D
G M Piersol, M D
C S Wright, M D
R L Gilman, M D
J P Guequierre, M D
D M Pillsbury M D
J C Yaskin M D
D Smelzer, M D
H Beerman, M D
- Roentgen Diagnosis*
- Illustrated lectures on the application of roentgenography in the diagnosis of disease 28 G E Pfahler M D
K Kornblum M D
E P Pendergrass M D
R S Bromer M D
B P Widmann, M D
- Conference on roentgen diagnosis, films of interesting cases shown by attending radiologist 64 E P Pendergrass M D
- Demonstration of application of roentgen diagnosis in surgical conditions 30 K Kornblum M D
- Conference on roentgen diagnosis 32 Radiologic Staff of Phila Gen Hospital
- Pediatric roentgenography 22 R S Bromer, M D
- Roentgen diagnosis of disease and injury of bones and joints 30 T A Henderson M D
- Roentgen diagnosis of arthritis 4 E W Spaekman M D
- Roentgenography of disease and injury to the cranial vault and its contents 20 K Kornblum M D
- Localization of opaque foreign bodies in the eye 5 E W Spaekman M D
- Roentgenologic diagnosis of disease of the paranasal sinuses 10 E P Pendergrass M D
- Roentgenography of the mastoid 10 P J Hodes, M D
- Roentgen diagnosis of mouth and jaw 2 P A Bishop, M D
- Roentgen technic and diagnosis of teeth and jaws 16 L M Ennis, M D
- Roentgen diagnosis of disease of urinary tract 30 K Kornblum, M D
- Uterosalphingography, technic and interpretation 2 P A Bishop, M D
- Pelvimetry history technic and interpretation 2 R P Barden, M D
- Interpretation of the cardiac silhouette, normal and abnormal 20 H W Ostrum, M D
- Roentgen diagnosis of non tuberculous infections and neoplastic disease of the lung 10 F K Alexander M D
- Roentgen diagnosis of pulmonary tuberculosis, demonstration of pneumothorax therapy and indications for its use 17 J Gershon Cohen M D
- Importance of serial films of equal quality in the study of tuberculosis of the lung, relation of non specific infection of lung bases to healing of tuberculosis of the lung 4 M McPhedran M D
- Roentgenography of esophagus stomach and duodenum 2 K Kornblum M D
- Roentgenography of gall bladder 2 W C Hall M D
- Roentgenography of intestines appendix, and rectum 2 J Gershon Cohen M D
- Roentgenography of bones 2 R S Bromer M D
- Roentgenography of tendons muscles joints and blood vessels 2 F K Alexander M D

Roentgen and Radium Therapy

- These lectures and demonstrations are correlated as nearly as possible with the pathology lectures Hours
- Application of roentgen and radium irradiation in the treatment of disease, discussion of various special technics, observation of effect of irradiation on tissues 31 G E Pfahler M D

every school of medicine There may be didactic lectures, clinico-radiologic conferences, pathologico-radiologic conferences, trimester clerkships, during which students accompany their patients throughout radiologic examinations, roentgenogram demonstrations, to small groups, elective courses in respiratory or gastrointestinal tract diseases, tumor conferences, and various combinations of the above methods The conferences, which are very popular with, and apparently very profitable to, the students, seem to be a method of instruction acceptable alike to most radiologists and clinicians

No statement of hours, or catalogue tabulations, could give an adequate idea of the instruction in radiology of the various medical schools In the vast majority, instruction seems adequate, in others, either lacking or topheavy With so many different methods of approach to one subject, there is much to be gained from an interchange of opinions In no instance did I obtain the impression that the radiologist was trying to further the interests of either himself or his specialty On the other hand, the radiologist seemed to have an earnest desire to assist in teaching the student to be a better doctor In most medical schools, there seemed to be an excellent *esprit de corps* between the radiologists and other departmental heads Co-operation, of course, is an essential feature in any comprehensive plan of medical education

SYNOPSIS OF STATISTICS FROM QUESTIONNAIRES RETURNED FROM 74 RECOGNIZED MEDICAL SCHOOLS IN THE UNITED STATES AND CANADA CONCERNING UNDERGRADUATE INSTRUCTION IN RADIOLOGY

Length of Course (Medical) —Two years, 6, four years, 65, six years, 3

Instruction in Radiology —Given in 71 schools

Department of Radiology —Separate, 38 schools, under Surgery, 15 schools, under Medicine, 13 schools, under Pathology, 1 school, no department, 7 schools

College Rank of Teacher —Professor, 50

schools, Associate Professor, 8 schools, Assistant Professor, 4 schools, Instructor, 4 schools, Lecturer, 2 schools

First-year Instruction —Given in 39 schools, usually taught in conjunction with Anatomy

Second-year Instruction —Given in 39 schools, generally in conjunction with Physiology and Pathology

Third-year Instruction —Given in 56 schools, 20–30 hours didactic lectures, some seminar or clinical conferences, ward rounds, etc

Fourth-year Instruction —Given in 59 schools, 30–40 hours (some as low as 10 hours, others as high as 60 hours), course often optional or in correlation with outpatient department, some practical application of theory, interpretation of films, etc

Six-year Courses —One school, fifth and sixth years, one school, second, fifth, and sixth years, one school, fifth year only

Clinical Conferences —Thirty - three schools

Elective Courses —Fifteen schools

The above statistics indicate that there has been a tremendous increase in the use of radiology in teaching during the last few years Such information is encouraging, but, at the same time, carries with it an enormous obligation, which we, as radiologists, should strive to fulfill To comprehend the situation more fully, compare the present statistics with those of Hickey (6), who states that prior to 1900, radiology was taught to undergraduates in only one college in America, from 1900–1910, in 15 colleges, 1910–1920, in 20 colleges, and 1920–1928, 52³ colleges

VIII GRADUATE INSTRUCTION IN THE SPECIALTY OF RADIOLOGY

The requirements for training the physician who desires to become a specialist in radiology are general and inclusive, but not specific This lack of specific requirements

³ Hickey's original article states only eight, but this number is obviously incorrect since data were collected from 52 institutions

used on his patients, the Fellow gets an insight in the handling of various lesions. He is taught to watch for the different skin reactions as they appear and, in addition, their proper care. Actual discussion of patients is not stressed during the time the Fellow is engrossed in mastering fundamentals. Daily ward rounds and seeing patients in "follow up" are a part of his duties at this time, however.

Following this period, the Fellow begins to assist in the actual handling of all new ward patients admitted for radiation therapy. He is expected to work up each patient from the clinical standpoint, after which the appropriate treatment is outlined. This phase of the training is, of a necessity, amply supervised. The Fellow is further expected to prepare depth dose measurements, as a part of the permanent record. By this time, he watches every patient being set up for therapy and gradually takes over the responsibility for this procedure in some patients.

As varying types of malignancy or non-malignant conditions are seen, collateral reading, with particular bearing on the treatment of the disease in question, is assigned to the Fellow. These articles are presented in abstract three times a week, as previously described.

From time to time, as patients requiring topical and interstitial radium present themselves, the problem of radium therapy is discussed. Under proper supervision, the Fellow is required to make up many of the radium applicators. In addition, he assists in all electro-surgical procedures performed by the radiologic staff. He is also expected to attend autopsies of radiologic interest.

This outlines, briefly, the type of training given to our Fellows in Radiology. On completion of the Fellowship, those physicians of unusual ability may remain as semi-permanent members of the staff until such time as satisfactory positions elsewhere become available. This obviates the necessity of a good man's

having to accept the first offer that presents itself.

IX GRADUATE INSTRUCTION FOR THE ESTABLISHED SPECIALIST

Every radiologist must continue to be a student throughout his professional life, if he is to fulfill his obligation of supplying satisfactory medical service in his individual community. At present, there is no comprehensive plan for keeping the radiologist abreast of new contributions to medical science. There are, of course, the meetings of medical societies, medical periodicals, the occasional itinerant course, and post-graduate assemblies. All of the foregoing are absolutely essential, but some other plan must be devised to keep the radiologist who is certified as a specialist acquainted with current proficiencies. To assist in accomplishing this objective, two plans are being considered.

Special Courses at Annual Meetings—In other branches of medicine, such as ophthalmology and otolaryngology, a "Section on Instruction" has been created as an integral part of the annual meeting of these organizations. The Radiological Society of North America has used this plan for years with considerable success. Their conferences are well attended and popular. The instructors are radiologists and teachers in allied branches and each is an authority on the subject he presents. Sufficient time is allotted for a comprehensive presentation and discussion of a subject. This type of post-graduate training needs further development.

Short Advanced Courses at Selected Institutions—With only a few exceptions, there are no institutions providing advanced and refreshing courses for the radiological specialist. There is, however, an increasing demand for this type of instruction. The successful short and intensive courses are so organized that the doctor taking them is kept busy the entire day. The instruction is given by the senior members of the staff and is maintained on a high plane.

course as he may elect, events have seemed fully to justify the custom, and almost invariably the period has been well employed

"Examinations at intervals during the course are desirable to determine whether the student is progressing satisfactorily, and are required by the American Board of Radiology. In some institutions the student is given an alphabetical rating at the end of each quarter by his instructors, and if at any period his rating falls below 'B,' he becomes ineligible for an advanced degree, although such forfeiture does not bar him from continuing his course. Six (6) months after admission, all students in radiology at certain institutions are subjected to examination in the basic sciences of medicine, and the wisdom of applying this test is obvious. Institutions which grant the degree of M S in Radiology after the candidate has completed three (3) years of study require him to submit a thesis for approval and pass an examination designed to prove his competence."

There are others, such as Golden (7), who feel that the graduate student should be introduced directly into diagnostic radi-

ology, before taking up the basic sciences. These men think that the needs and applications of the fundamental training will be appreciated more under such circumstances.

The established graduate schools want full and complete understanding of the Council's prescribed courses in order to plan their curriculum accordingly. Due to the absence of any definite program, such institutions have been compelled to place their own interpretation upon the requirements of the Council on Medical Education and Hospitals. To illustrate one temporary program of this nature, we offer the curriculum for graduate instruction in radiology as given at the Graduate School of Medicine of the University of Pennsylvania. As this curriculum is changed from year to year, in the light of additional experience, it must be evaluated only as a serious attempt to meet the specifications of a difficult requirement.

CURRICULUM IN RADIOLOGY, GRADUATE SCHOOL OF MEDICINE UNIVERSITY OF PENNSYLVANIA

<i>Anatomy</i>	Hours	
General anatomy as applied to roentgenography projection of normal parts on the roentgenogram	40	O V Batson M D
The general anatomy lectures are correlated with roentgen anatomy as follows		
Normal osseous roentgenologic anatomy	4	T A Henderson M D
Normal cranial roentgenologic anatomy	4	K Kornblum M D
Normal thoracic roentgenologic anatomy	4	F K Alexander M D
Normal gastro intestinal roentgenologic anatomy	4	J Gershon Cohen M D
Normal genito urinary roentgenologic anatomy	4	P A Bishop M D
<i>Physiology</i>		
Effect of irradiation on normal tissue	10	E Lodholz M D
Biological physiology of neoplastic disease	6	S P Reumann M D
<i>Pathology</i>		
General pathology	30	E A Case M D
Morbid anatomy observation of autopsies and correlation with previous roentgen findings	20	E A Case M D
Pathology of the heart	9	J Eiman M D
Pathological physiology of surgical conditions	45	S P Reumann M D
Hematology the pathological blood picture and its significance	15	M M Strumia M D
Tumor Conference consideration of current treatment problems as to future therapy	30	B P Widmann M D and staff
Tumor Conference, pathology and treatment of neoplastic disease	30	E P Pendergrass, M D
		P J Hodes M D
<i>Physics</i>		
Physics of production and use of roentgen rays in therapy physics of radium therapy	32	Mr J L Weatherwax
General consideration of electromagnetic radiation construction of x ray apparatus and physics of roentgenography	30	Mr C H Weyl
		Mr R Warren
<i>Biophysics</i>		
Relation between experimental and clinical radiology	60	R E Zerkel M D

THREE-YEAR RESULTS IN THE TREATMENT OF MALIGNANT NEOPLASMS WITH SUPERVOLTAGE ROENTGEN THERAPY¹

By T. LEUCUTIA, M.D., Department of Radiology, Harper Hospital, Detroit, Michigan

SUFFICIENT time has now elapsed since the introduction of supervoltage roentgen therapy so that one may estimate the merit of this technically and physically interesting method also from the clinical standpoint. It is even possible to compile statistical data and by arranging the results according to certain more or less standardized criteria one may draw survival curves which can easily be compared with those obtained with the 200 kv equivalent² radiation therapy. Such curves acquire special documentary value when they express the continuation of a work in one and the same institution over a long period of time. In Harper Hospital, a total of 312 cases of malignant neoplasms were treated during the years of 1933 and 1934 by supervoltage roentgen therapy, mostly with 500 kv equivalent (7 mm Cu filter) radiation. These cases were compared, on the basis of survival rates, with those treated with the 200 kv equivalent radiation prior to those years and survival curves were drawn which in some instances extended as far back as 1922 (15 years). In the present paper, the three-year results obtained with supervoltage roentgen therapy are presented, and in order to bring out the comparative value of the two types of radiation to greater advantage the material is divided into three main groups: (1) cases which proved complete failures to the 200 kv equivalent radiation and later were subjected to supplemental irradiation with 500 kv equivalent,

(2) cases which were primarily irradiated with 500 kv equivalent but in which results or survival curves showed no change from the 200 kv equivalent radiation therapy, (3) cases which were primarily irradiated with 500 kv equivalent and in which there was a very definite improvement as compared to the 200 kv equivalent radiation therapy.

(1) The cases of the first group are shown in Table I.

TABLE I—DEEP THERAPY FAILURES SECONDARILY TREATED WITH SUPERVOLTAGE THERAPY (1933-1934) STAGES IV-V

Type of Malignancy	Year	Total	Alive
Breast cancer	1933	6	—
	1934	2	1
Gastro-intestinal cancer	1933	5	—
	1934	6	—
Genito-urinary malignancy	1933	—	—
	1934	5	—
Oral cancer	1933	4	1
	1934	3	—
Sarcoma	1933	4	—
	1934	6	—
Uterine cancer	1933	18	1
	1934	17	2
Ovarian malignancy	1933	7	1
	1934	1	—
Various malignancies	1933	2	—
	1934	7	1
Total	8 per cent	93	7

It is noted that of 93 cases of 200 kv equivalent roentgen therapy failures which were secondarily irradiated with 500 kv equivalent, only seven (8 per cent) were alive after three years and in most of these instances the disease was not entirely eradicated. One may add that only such cases were considered as primary failures to the 200 kv equivalent roentgen therapy in which the dose was carried to the upper-

¹ Presented before the Fifth International Congress of Radiology, in Chicago Sept 13-17 1937.

² The term "equivalent" in specifying the quality of the radiation employed for treatment is used in order to differentiate it from other values as, for example, would be 500 kv "peak." It appears that irradiation obtained by 500 kv equivalent corresponds to the quality of the radiation obtained by about 750 kv peak. Thus without specifying one or the other one may be apt to misconstrue the results especially as it concerns the reaction.

Use of radium and radon in treatment of neoplastic disease, demonstrations of purification and standardization of radon	32	B P Widmann, M D
Observation of diagnosis, technic, and dosage of irradiation	24	B P Widmann, M D
progress of lesions, tumor clinic of Phila. Gen. Hospital	2	G E Pfahler, M D
Therapy of mouth and jaws	2	F D Weidman, M D
Therapy of non-malignant disease of skin	2	B P Widmann, M D
Therapy of malignant disease of skin	2	Elwood Downs M D
Therapy of infections of skin and subcutaneous tissue	2	Lowry Allen, M D
Therapy of lymphatic glands, spleen, and leukemias	2	G E Pfahler, M D
Therapy of kidney bladder, and prostatic tumors	2	J Gershon Cohen, M D
Therapy of tumors of testicle and scrotum	2	

Clinics in Radiology

University Hospital
Philadelphia General Hospital
Graduate Hospital

E P Pendergrass M D, and Associates
B P Widmann, M D, and Associates
K Kornblum, M D, and Associates

The graduate class in radiology spends 30 days attending clinics at these three hospitals. Their time is divided between diagnosis and therapy.

After the completion of the first year (8 months) in the Graduate School, the student enters upon his course of clinical training in diagnosis and therapy, which, at the University of Pennsylvania, is upon a Fellowship basis. The student is taught the general routine of the department, the handling of patients, clinic, ward, and private, and the use of the general files, including the reports and films. During the first three months, training also covers developing, processing, and technical radiography. *All of the patients must be seen by a doctor, who outlines the desired examination.*

As the Fellow in Radiology becomes more experienced, he is given more responsibility, his duties being divided between clinical and research. The research work is done under the direction of the Professor of Research Surgery, the Professor of Medical Biophysics, and the Professor of Radiology, either individually or jointly. The clinical duties include

Fluoroscopy—Examination of patients for chest and abdomen films, gastrointestinal examinations on ward and clinic patients.

Film Interpretation—Interpretation of ward examinations twice a week, observation of a part or all of the film interpretation by the chief or his associates.

Emergencies—On call nights and week-

ends to perform and interpret all roentgen examinations, every other week.

Classes—Several weekly clinico-radiologic conferences, including medical, surgical, pediatric, and obstetrical departments. Weekly tumor conference.

After the completion of one year in diagnostic radiology, the Fellow is assigned to therapy, which includes some of the various types of roentgen and radium therapy and electro-surgical procedures. In the first two months, the Fellow is taught how to operate the different roentgen therapy machines. During this period, he acts as a technician. A certain number of patients are assigned to him for treatment, with responsibility for the mechanical and clinical portions of the patient's roentgen therapy. In addition, he observes how the machines are calibrated and also takes care of the therapy records.

During the time the Fellow acts as a technician, he is expected to do collateral reading. This is supervised in such a manner that only the better articles on roentgen therapy are studied. One-half hour is reserved three days a week for the Fellow to give an abstract of whatever article he has read. At this time, any questionable points are clarified and an effort is made to show the student the practical value of his reading. In such a manner are discussed the leading articles on data concerning filtration, voltage, milliamperage, distance, etc., with which the Fellow must become acquainted. By observing the plan of treatment

energy absorption exists. Because of the decreasing photoelectric and increasing Compton effect, on one hand, and because of the greater penetration and more straightforward scattering, on the other, the amount of radiation which is delivered to various tissue depths increases gradually with increasing voltages. Hence one may surmise that better absorption conditions are created which lead to a better differential effect. Since such factors are functions depending on the wave length of the irradiating beam, we may concede that the differential action represents an "indirect quality dependence" at the least. From a practical standpoint this means that a larger total dose may be administered to a certain neoplasm when using higher voltages than is possible with the 200 kv equivalent radiation and that at the same time there is less injury to the skin. In other words, the irradiation becomes more homogeneous and efficacious.

The second circumstance is the result of the nature of the neoplasm and its stage of clinical development. For the past fifteen years it has been the custom at Harper Hospital to classify all malignant neoplasms, as far as possible, into five stages, according to the degree of demonstrable clinical extension. I, local lesion, II, metastases to the first regional lymph nodes, III, metastases to the second regional lymph nodes through anastomosis with the first, IV, wide local invasion by continuity, and V, distant metastases. When supervoltage roentgen therapy was first introduced in 1933 and during the following year of 1934, it was applied chiefly to cases of Stages III and IV. The cases in Stages I and II are considered operable and, therefore, in these groups the old established methods of treatment were pursued either by employing an association of surgery and irradiation or by irradiation alone with a technic as formerly practised. Stage V, on the other hand, represents such extensive dissemination of the malignant process that the possibility of a cure is practically eliminated, whereas palliation may be brought

about by other less expensive methods. It was our impression from the beginning that the greatest improvement by the supervoltage roentgen therapy may be produced in Stage IV in those types of tumors which remain of local character for a long while, although the invasion by continuity may be a very considerable one. To use a few illustrations, a carcinoma of the breast is placed in Stage IV when there is invasion with adherence of the anterior thoracic wall, a carcinoma of the cervix when there is a completely frozen pelvis, even associated with communicating recto- or vesicovaginal fistulae, a carcinoma of the larynx when there is extrinsic invasion of the structures of the neck, a carcinoma of the skin when there is invasion of the underlying bone, a carcinoma of the rectum when there is extension into the perirectal structures, etc.

By radiating such situations with 500 kv equivalent roentgen rays, indeed, at times very surprising results were obtained. The best example is represented by the carcinoma of the uterine cervix. Figure 1 shows the survival curves in our material for three, five, and ten years in a total of 531 cases treated since 1922. There hardly can be any doubt that the three-year survival curve has undergone a very remarkable rise since the introduction of the supervoltage roentgen therapy, the percentage increasing from 30 to nearly 60. Perhaps one should mention that the curves up to 1933 included all cases examined, whether properly or improperly treated, and thus represent absolute values, whereas the three-year curve since 1933 includes only those cases which received proper irradiation with supervoltage roentgen therapy (and intracavitary radium) and thus represent relative values. But even so, the improvement cannot be denied. In many instances, advanced cases with communicating fistulae have led to complete healing, there being no evidence of carcinoma whatsoever three years later. It appears thus that carcinoma of the uterine cervix remains localized to the pelvic structures for a relatively long while,

CONCLUSION

In concluding this paper, which presents in detail the development of undergraduate and graduate instruction in radiology during the past few years, along with a discussion of some of the prevailing methods of instruction, it seems to me that an excerpt from an address by Harold W Dodds (8), President of Princeton University, is peculiarly fitting

"Plato's immortal allegory of the men chained in a cave was never more appropriate than to-day. You remember that the unfortunate creatures, representing society in general, are bound in the darkness with their faces to the wall, that there is a fire behind them, and that real figures pass between them and the fire so that the imprisoned men can see the shadows of the figures on the wall, but never the figures themselves in reality. Occasionally a prisoner is freed from his chains and led above to the daylight, where he learns the realities behind the shadows and learns how imperfect were his earlier impressions. Thereafter, it becomes his duty to return to the cave and help disperse the ignorance of his fellows."

Does not this allegory express the opportunity and obligation the radiologist owes to medicine? Is it not our duty, having seen the reality, to train men with the talent, the intellect, and the will to work, so that they, in turn, may be able properly to interpret the shadows in the light of modern physiology and pathology?

BIBLIOGRAPHY

- (1) SKINNER E H Radiologic Societies and Literature, The Science of Radiology Charles C Thomas Springfield Ill, 1933
- (2) Medical Education Final Report of the Commission on Medical Education, 1932
- (3) HEYD, C G The Relation of the American Medical Association to Certification of Specialists Jour Am Med Assn March 27 1937, 108, 1017-1019
- (4) SANGER, H F Co-operation between Organized Radiology and the American Medical Association Am Coll Radiol 1936, Bull 3 pp 9-14
- (5) KIRKLIN, B R Education and Training of Prospective Radiologists Am Coll Radiol, 1936 Bull 3 pp 24-28
- (6) HICKEY, P M Teaching of Roentgenology in America Acta Radiologica, 1930 Supp 4 pp 34-40
- (7) GOLDEN, ROSS Personal communication
- (8) DODDS, H W Princeton's Job Princeton Alumni Weekly 1937 37, 596

a study of the survival curves in these cases

(1) If a thorough irradiation with 200 kv equivalent has led to failure in a certain instance, the supplemental irradiation with 500 kv produced no material improvement in the final results

(2) In the cases primarily treated with supervoltage roentgen therapy no change in the law of radiosensitivity was observed as compared to the 200 kv radiation. It appeared in this respect that there is no direct quality dependence or selective reaction. The groups of malignant tumors which proved unfavorable to the 200 kv equivalent irradiation continued to remain unfavorable also to the 500 kv equivalent irradiation.

3 Primary supervoltage roentgen therapy with or without association of other methods led to better results in all those instances in which the irradiation has been rendered more efficacious, as compared to the 200 kv equivalent radiation, but in

which the malignant process was still of local character although the invasion by continuity appeared very considerable. The increased efficacy may be attributed to better absorption conditions, signifying an indirect quality dependence or differential action. If all malignant neoplasms are divided into five clinical stages, it is found that supervoltage roentgen therapy has led to definite improvement of the three-year results in Stages III and IV, in those groups which were favorable also to the 200 kv equivalent radiation. The best example is represented by the carcinoma of the uterine cervix in which the percentage of three-year survival was increased from 30 to nearly 60. A similar improvement was obtained in certain bulky skin cancers, in carcinoma of the rectum, in the earlier cases of carcinoma of the prostate, in some types of sarcoma, in carcinoma of the thyroid, and to a lesser extent in metastatic carcinoma of the lymph nodes of the neck.

most limit of skin tolerance and yet the pathologic lesion continued to show unabated clinical progress. It thus appears that by secondarily subjecting such cases to roentgen therapy with more penetrating rays—in other words, by changing the quality of radiation—a very small or practically no material improvement is obtained as far as the final results are concerned.

(2) In the cases primarily treated by supervoltage roentgen therapy, it was observed that the law of radiosensitivity of the various tumoral tissues remained essentially the same as known for the deep roentgen therapy. Tumors that responded readily to the 200 kv equivalent radiation were found to respond readily also to the 500 kv equivalent radiation. On the other hand, such unfavorable groups to the 200 kv equivalent radiation as malignant neoplasms of the gastro-intestinal tract, with the exclusion of carcinoma of the rectum, or melanosarcoma, etc., continued to show the same unfavorable results also with the 500 kv equivalent radiation. It appeared in this respect that there was no direct quality dependence with increasing voltages and that, therefore, nothing could be gained by replacing deep roentgen therapy with supervoltage roentgen therapy purely on such a basis, all other factors remaining identical. Perhaps one may mention that the phrase "direct quality dependence" is used in the sense of "selective" action as defined by Russ and Scott, according to which a selective action of an irradiation occurs when a beam in passing through a collection of cells causes some varieties to be more affected than others, quite irrespective of the variation in the intensity of the irradiation as it goes from one point to another or from plane to plane.

In Table II are included the results of some of the unfavorable groups, as well as other more favorable groups but in which the addition of supervoltage roentgen therapy has brought no amelioration worthy of note over the 200 kv equivalent radiation. The reason for lack of improvement in these latter may be sought either

in the fact that the irradiation situations were little changed, if any, from those of the 200 kv equivalent radiation, or that the malignant process has already advanced to a stage which was beyond the reach of a permanent cure.

TABLE II—CASES PRIMARILY TREATED WITH SUPERVOLTAGE THERAPY (1933-1934) UN-INFLUENCED GROUPS

Type of Malignancy	Year	Stage	Total	Alive
Breast cancer	1933	IV-V	5	—
	1934	II	2	2
		III-V	7	—
Gastro-int cancer, including cancer of rectum	1933	IV-V	9	1
	1934	IV-V	19	2
Genito-urinary malignancy, including cancer of bladder and prostate	1933	IV-V	6	1
	1934	IV-V	15	1
Ovarian malignancy	1933	V	5	—
	1934	V	6	—
Cancer of larynx	1933	IV	2	—
	1934	IV	11	2
Less II			87	9
Total 8 per cent			2	2
			85	7

(3) Primary supervoltage roentgen therapy with or without association of other methods may be expected to yield better results than the 200 kv equivalent radiation under two circumstances: first, if the radiation has been rendered more efficacious, and second, if the lesion, or malignant neoplasm, is of such a nature as to remain localized for a longer while. As far as the first circumstance is concerned, it appears quite safe to state now that with increasing voltages there is a better differential action of the radiation. According to Russ and Scott, a "differential" action occurs when different biological effects take place in any particular tissue after exposure to radiation of different wave lengths. The nature of such action is not altogether clear but as experimental evidence accumulates, it becomes more and more obvious that a certain relation to

generative changes in many of these cases which are capable of producing only localized symptoms due to the fact that they are separated too far from the nerve roots. One example of this is the sclerosis and spur formation so frequently seen in the anomalous spine involving the inferior margins of the sacro-iliac joint. Another example is the degenerative change involving the joint formed by the anomalous transverse process of the fifth lumbar vertebra and the lateral mass of the first sacral vertebra. To ascribe to such changes anything more than localized pain and protective spasm is not in keeping with the anatomy of the part.

The primary purpose of this paper is to deal with those changes which are responsible for segmental pain which radiates into the extremities. Less severe nerve symptoms which will not be discussed but which should be mentioned are those which accompany the twelfth dorsal and upper lumbar segments. Such cases usually present a pelvic obliquity and a primary

lumbar curve. The symptoms appear as a hyperesthetic zone corresponding to the dermatome of one or more of the segments mentioned. The change is most frequently found on the side which corresponds to the concavity of the curve and is probably due to the reaction caused by the abnormal stress thrown on the facets of the concave side. Similar nerve changes are frequently found in cases of scoliosis due to other causes.

The intervertebral disk which joins an anomalous vertebra with the segment below is usually thin and rudimentary in character. It is unlikely that the prolapse of such a disk or its nucleus into the neural canal would play any part in the production of segmental symptoms, however, this question remains to be proven.

SACRALIZATION

Sacralization of the fifth lumbar vertebra was found in 7 per cent of the cases. Its occurrence was more frequent in the female than in the male. The fixation may

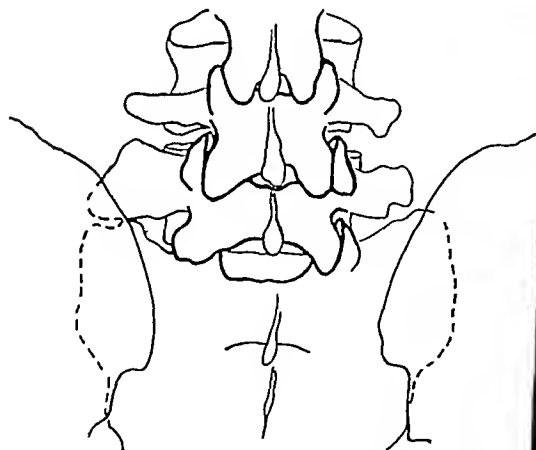


Fig 1 Unilateral sacralization showing subluxation of the articular facets between the fourth and fifth lumbar vertebrae and the lumbo-sacral facets on the free side.

SURVIVAL CURVES IN CARCINOMA OF CERVIX

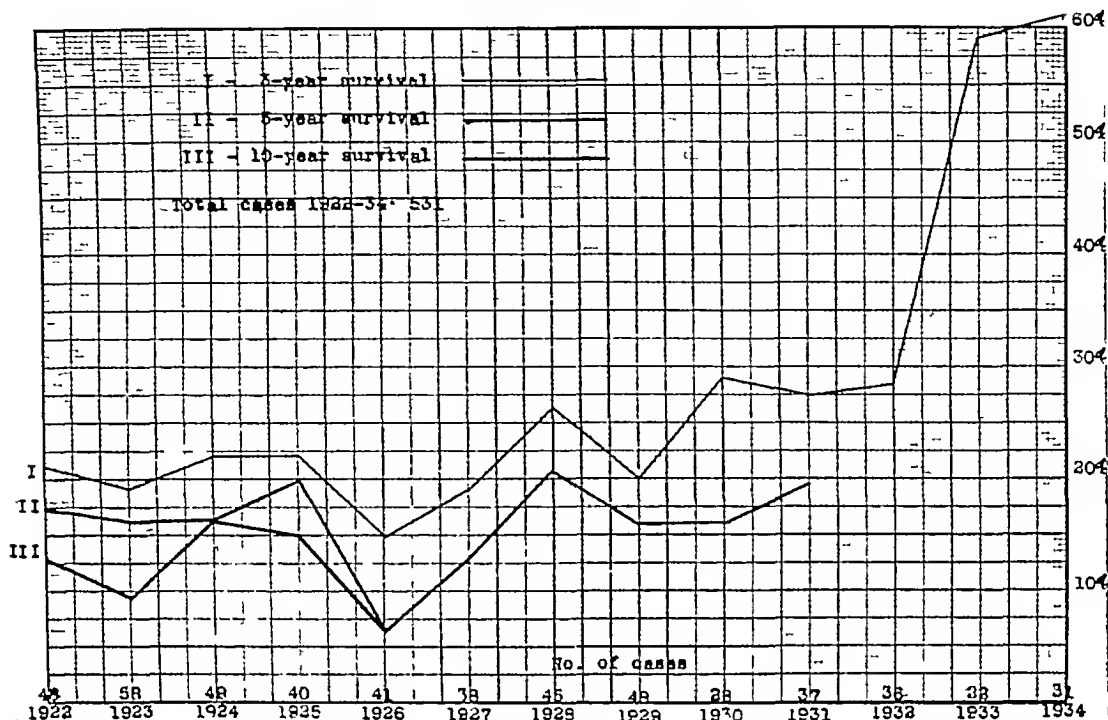


Fig 1

fatal complications arising nearly always through effect on the neighboring organs, and that the more efficacious irradiation with the supervoltage roentgen therapy (and radium) can lead to cure in the most advanced cases, there being no, or very little, danger of distant metastases

A similar situation exists in certain bulky skin cancers with invasion of the underlying bone, in carcinoma of the rectum and the earlier cases of carcinoma of the prostate, in some types of sarcoma, in carcinoma of the thyroid and to a lesser extent in metastatic carcinoma to the lymph nodes of the neck (either from oral or mammary primary). In a total of 122 such cases of Stages III, IV, and V, the three-year survival was 40 per cent. The results in these cases are shown in Table III.

SUMMARY AND CONCLUSIONS

A total of 312 cases of malignant neoplasms were treated during 1933 and 1934 at Harper Hospital by supervoltage roent-

gen therapy, mostly with 500 kv equivalent (7 mm Cu forefilter) radiation. The following conclusions may be drawn from

TABLE III—CASES PRIMARILY TREATED WITH SUPERVOLTAGE THERAPY (1933-1934) IMPROVED GROUPS

Type of Malignancy	Year	Stage	Total	Alive
Skin cancer (bulky)	1933	IV	1	—
	1934	IV	6	3
Cancer of thyroid	1933	IV-V	2	1
	1934	III-V	3	2
Cancer of bronchus	1933	I-V	8	1
	1934	I-V	5	2
Oral cancer with metastasis to glands of neck	1933	III-V	12	2
	1934	I	3	3
		III-V	11	1
Sarcoma	1933		7	1
	1934		17	7
Uterine cancer	1933	A-II	2	2
		IV-V	21	12
	1934	A-I-II	5	5
		IV-V	29	17
Total			132	59
Less I-II			10	10
Total 40 per cent			122	49

The x-rays reveal a narrowing of the fifth lumbar intervertebral disk and a subluxation of the lumbo-sacral facets on the side opposite the fixed transverse process (Fig 2). If the history of pain dates from young adult life there will also be observed a narrowing of the fourth lumbar intervertebral disk and a subluxation of the facets between the fourth and fifth lumbar vertebrae as shown in Figure 1.

Bilateral sacralization of the fifth lumbar vertebra, providing there is bony or good fibrous fixation, is an excellent assurance against degenerative changes of the lumbo-sacral articulation. When symptoms from such a lesion appear early in life there is usually a definite history of injury. When they appear in middle life the onset as a rule is insidious in character. Segmental symptoms accompanying this lesion follow primarily the distribution of the fourth lumbar nerve on either side.

The x-rays reveal a narrowing of the fourth lumbar intervertebral disk and a

subluxation of the corresponding facets. The degree depends on the duration of the lesion (Fig 3).

LUMBARIZATION

Lumbarization of the first sacral vertebra was found in 87.5 per cent of the cases in this series. Its occurrence was slightly more frequent in the male than in the female. Like the former lesion, it may be either unilateral or bilateral, and clinical symptoms are due to traumatic degenerative changes caused by altered mechanics.

Unilateral lumbarization may cause segmental symptoms, in addition to localized pain, as a result of traumatic degenerative changes at two different sites. Patients presenting this anomaly and who suffer symptoms during young adult life usually give a history of injury. If the pain radiates down the extremity, it follows primarily the distribution of the fifth lumbar nerve. Either extremity may be involved.

The x-rays on such a patient will reveal

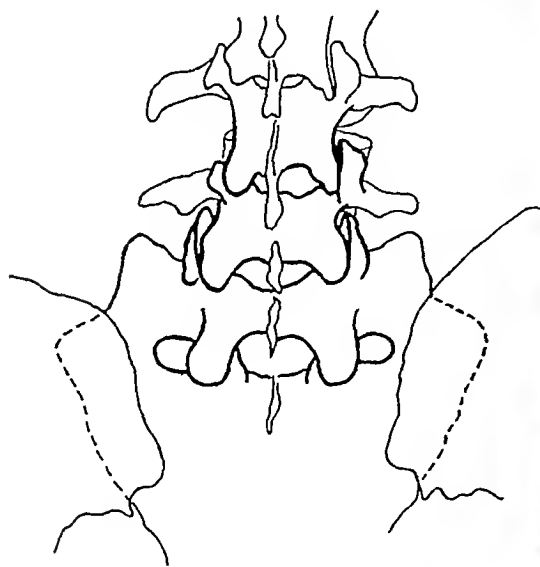


Fig 3 Bilateral sacralization showing subluxation of the articular facets between the fourth and fifth lumbar vertebrae.

ANOMALIES OF THE LUMBO-SACRAL SPINE¹

By PAUL C WILLIAMS, M D , *Dallas, Texas*

It has long been the opinion of those who have had occasion to deal with orthopedic problems that an anomalous lumbo-sacral spine is capable of producing pain. The exact cause of symptoms in those patients presenting such a lesion has been and yet remains a subject of controversy.

Schmorl from his extensive postmortem studies did not venture far into the clinical aspect but apparently was of the opinion that clinical symptoms in such cases were due to secondary degenerative changes.

The bizarre clinical findings presented by these patients are going to require the best combined efforts of the radiologist, neurologist, and the orthopedist before a satisfactory explanation can be made and a rational form of treatment established. It is probable that when all secondary pathologic changes are understood it will be unnecessary to resort to vague terms in explaining pain distributions.

When one realizes that there are at least 18 different muscles in each lower extremity which receive part of their innervation from the fifth lumbar segment, it is not difficult to understand the widespread distribution of pain presented by a patient suffering with a lesion of this segment. Sensory distributions are also confusing. This has been demonstrated by the classical work of Foerster who has shown a wide individual variation in distributions and extensive overlapping of the dermatomes of the lower extremities. In those cases presenting an extra vertebra there is undoubtedly an extra nerve segment which adds further to the confusion of the neural examination.

It has been found by the author from a study of 1,000 patients who complained of pain in the lower part of the back and

legs that the x-ray studies of approximately 30 per cent showed an anomaly of the lumbo-sacral spine. About 16 per cent presented the anomalies commonly spoken of as lumbarization and sacralization. While this terminology will be employed in this paper it is not wholly adaptable due to the fact that an occasional case actually presents an extra-vertebral segment within the column. For this reason, unless studies of the entire spine are available, it is well to use the terminology of Schmorl who has spoken of these segments as lumbo-sacral transitional vertebræ.

Since x-ray studies of the entire column were not available in all cases in this series it has been necessary to classify according to the number of sacral segments presented. Thus the term "lumbarization" indicates that there are four sacral vertebræ below the anomalous segment, while "sacralization" indicates that there are five sacral vertebræ below the anomalous segment.

The accompanying classification with the percentage of occurrence of each lesion includes only those anomalies which in the author's opinion are responsible for clinical symptoms.

	<i>Lesion</i>	<i>Percentage Occurrence</i>
1	Sacralization	7 00
2	Lumbarization	8 75
3	Imperfect fusion of sacral lateral masses	7 75
4	Spondylolisthesis	3 25
5	Facet fragmentation and anomalies	2 00
	Total	28 75

The majority of patients suffering with anomalous lumbo-sacral spines present both localized and segmental symptoms. When a nerve root approximates a degenerative bone change so closely that it becomes irritated, either by an inflammatory reaction or direct mechanical contact, segmental symptoms result. There are de-

¹ Presented before the 15th International Congress of Radiology in Chicago Sept. 13-17, 1937.

The x-rays reveal a narrowing of the fifth lumbar intervertebral disk and a subluxation of the lumbo-sacral facets on the side opposite the fixed transverse process (Fig. 2). If the history of pain dates from young adult life there will also be observed a narrowing of the fourth lumbar intervertebral disk and a subluxation of the facets between the fourth and fifth lumbar vertebrae as shown in Figure 1.

Bilateral sacralization of the fifth lumbar vertebra, providing there is bony or good fibrous fixation, is an excellent assurance against degenerative changes of the lumbo-sacral articulation. When symptoms from such a lesion appear early in life there is usually a definite history of injury. When they appear in middle life the onset as a rule is insidious in character. Segmental symptoms accompanying this lesion follow primarily the distribution of the fourth lumbar nerve on either side.

The x-rays reveal a narrowing of the fourth lumbar intervertebral disk and a

subluxation of the corresponding facets. The degree depends on the duration of the lesion (Fig. 3).

LUMBARIZATION

Lumbarization of the first sacral vertebra was found in 87.5 per cent of the cases in this series. Its occurrence was slightly more frequent in the male than in the female. Like the former lesion, it may be either unilateral or bilateral, and clinical symptoms are due to traumatic degenerative changes caused by altered mechanics.

Unilateral lumbarization may cause segmental symptoms, in addition to localized pain, as a result of traumatic degenerative changes at two different sites. Patients presenting this anomaly and who suffer symptoms during young adult life usually give a history of injury. If the pain radiates down the extremity, it follows primarily the distribution of the fifth lumbar nerve. Either extremity may be involved.

The x-rays on such a patient will reveal

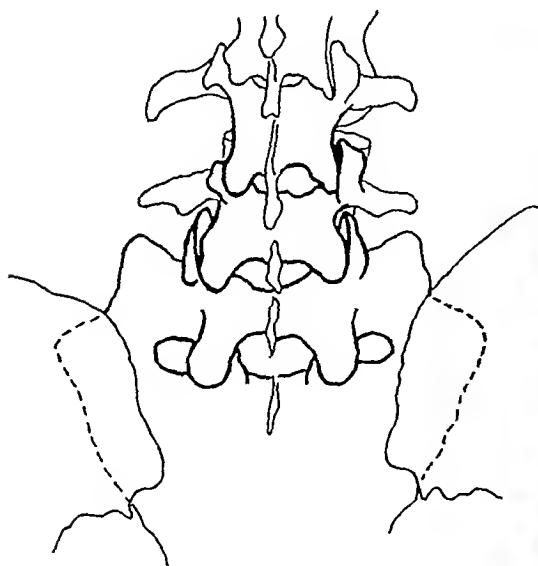


Fig. 3. Bilateral sacralization showing subluxation of the articular facets between the fourth and fifth lumbar vertebrae.

either unilateral or bilateral. Segmental symptoms resulting from such a lesion are not due to the anomaly itself, but to the lesion of the fourth lumbar vertebræ (Fig 1). There is also a narrowing of the posterior portion of the fourth lumbar intervertebral disk which may be but slight



Fig 2 Unilateral sacralization showing settling of the disk on the free side.

rather are caused by degenerative changes resulting from altered mechanics which have caused an abnormal stress on the intervertebral disk.

Symptoms resulting from a unilateral sacralization may appear in young adult life or may be delayed until middle life. When appearing in young adult life there is usually a history of injury. In addition to the localized symptoms these patients frequently complain of pain in the lower anterior thigh and knee on one or both sides. A history of the knee "giving way" is not uncommon. Segmental symptoms follow primarily the distribution of the fourth lumbar nerve.

Careful x-rays of such a case will reveal a subluxation of the articular facets between the fourth and fifth lumbar verte-

bra at this stage. The vertex of the lumbosacral angle is located between the fourth and fifth lumbar vertebræ rather than between the fifth lumbar and first sacral vertebræ. This indicates abnormal stress on the posterior fibers of the fourth lumbar intervertebral disk.

Providing the fourth lumbar intervertebral disk escapes acute traumatic changes, patients do not develop symptoms until they approach middle life. The usual course of events is a gradual onset of pain in the lower back, followed in a period of weeks, months, or years by pain radiating down the leg opposite the fixed transverse process to the posterior thigh and lateral aspect of the calf, ankle, and foot. Symptoms and findings follow the distribution of the fifth lumbar nerve.

tal symptoms throughout the distribution of the first sacral nerve on either side

The x-rays on such a case show degenera-

Segmental symptoms predominate in this lesion and follow the distribution of the fifth lumbar, first, second, and third sacral



Fig 5 Unilateral lumbarization showing narrowed rudimentary intervertebral disk and subluxation of facets on free side (retouched)

tive arthritic changes involving the rudimentary facets between the first and second sacral vertebrae in addition to the lumbosacral changes. Due to superimposed bony structures this is one of the most difficult cases to reveal by the x-ray, and for this reason a most careful technic must be employed (Fig 6)

IMPERFECT FUSION OF SACRAL LATERAL MASSES

Imperfect fusion of the sacral lateral masses was found in 7.75 per cent of the cases in this series. Its occurrence was found to be practically the same in the two sexes. In the majority of cases symptoms make their appearance in young adult life. There is usually a history of injury which may be comparatively mild in character

nerves. Pain through the third sacral nerve radiating into the scrotum in the male and the labia in the female invariably suggests pathologic changes of the genitourinary tract. For this reason these patients are investigated time and again for such changes.

It is possible that a prolapse of the nucleus pulposus of the fifth lumbar intervertebral disk is responsible for sacral nerve symptoms in this lesion. Again they may be due to irritation of the sacral nerves within the narrow sacral neural canal caused by motion between the first and second sacral vertebrae. The latter view has been strengthened by a case operated upon which revealed adhesions of the sacral nerves at this site. The fifth lumbar nerve changes which predominate after symptoms have

a subluxation of the lumbo-sacral facets and a narrowing of the lumbo-sacral intervertebral disk (Fig 4)

Patients presenting the same anomaly may not develop symptoms until middle or late life. Segmental symptoms following the course of the fifth lumbar nerve may be present on either side, but frequently there is also clinical evidence of first sacral nerve involvement on the side which corresponds to the lumbarized lateral sacral mass.

The x-rays on such a case in addition to the narrowing of the lumbo-sacral intervertebral disk and the subluxation of the lumbo-sacral facets show a narrowing of the rudimentary disk and a subluxation of the imperfectly developed facets between the first and second sacral vertebrae on the free side (Fig 5). The degenerative changes are usually quite apparent at this age period.

Bilateral lumbarization of the first sacral vertebra may or may not cause clinical symptoms, depending to a large extent on

the amount of mobility between the first and second sacral vertebrae.

The distribution of pain in those presenting this anomaly varies considerably with the age of the patient. If clinical symptoms appear between the ages of 20 and 45 and progress to the point at which pain is radiating down the lower extremities, it will be found that such symptoms follow primarily the distribution of the fifth lumbar nerve. Either extremity may be involved. Symptoms in these patients cannot be differentiated clinically from those whose x-rays show a destruction of the lumbo-sacral intervertebral disk without an anomalous spine.

The x-rays aside from the anomaly show a narrowing of the lumbo-sacral intervertebral disk and a subluxation of the corresponding facets. The degree as viewed in the roentgenogram varies directly with the duration of the destructive process.

After the age of 45, with or without the symptoms already described in the younger group, these patients may present segmen-

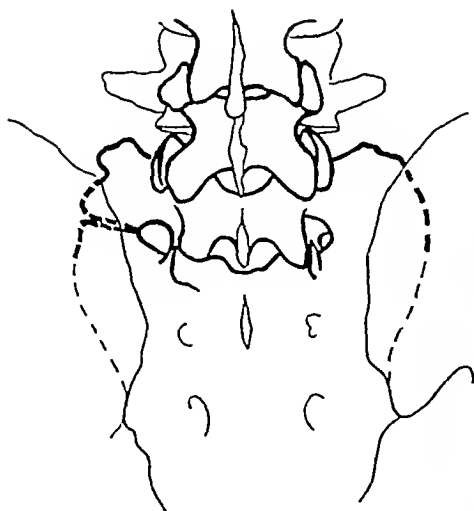


Fig 4 Unilateral lumbarization showing subluxation of the lumbo sacral facets



Fig 7 Spondylolisthesis showing break in pedicle of fifth lumbar vertebra and forward displacement of lumbar spine on first sacral table.

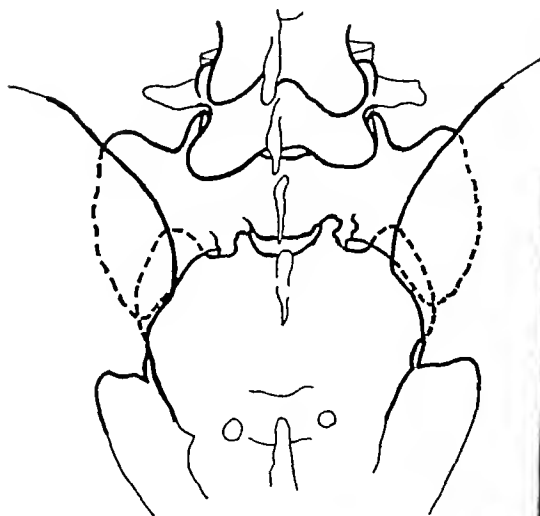


Fig 8 Imperfect fusion of sacral lateral masses changes involving inferior margin of sacro-iliac joints fusion of lumbo-sacral facets

x-ray, and gross findings suggested a fracture. Complete recovery followed surgical treatment.

Under this phase of the classification there have been included a few rare cases that presented symptoms characteristic of this group and whose x-ray studies showed an over-development of one of the first sacral facets. Aside from the magnitude of the facet there was evidence of sclerosis and marginal irregularity characteristic of a degenerative arthritic change.

Of the few cases seen, symptoms made their first appearance during the fourth decade of life, and clinical examinations revealed that segmental symptoms followed the distribution of the fifth lumbar nerve on the side which corresponded to that of the enlarged facet.

There are other anomalies of the lumbo-sacral spine which have not been included in this classification due to the fact that they play a secondary part in the production of symptoms. A spina bifida occulta of the first sacral vertebra is an example of such a lesion. This lesion in itself has no clinical significance, but when combined



Patient aged 15 years. Note degenerative arthritic changes involving inferior margin of sacro-iliac joints double articulation of sacrum and fusion of lumbo-sacral facets

become chronic must be explained on the basis of facet changes due to the fact that this nerve emerges from the canal without crossing the lumbo-sacral disk

From the x-ray study this lesion might well be considered the mildest form of a lumbarized first sacral segment. The lateral masses of the first and second sacral segments show an imperfect or complete failure of fusion. The sacrum forms a double articulation with the ilium, and traumatic degenerative changes involving the inferior borders of the sacro-iliac joint are evidenced by sclerosis and osteophyte formation at this site. Such changes may be observed as early as the latter half of the second decade of life. The lateral studies show a rudimentary intervertebral disk between the first and second sacral vertebrae. In most cases presenting this lesion there is a degeneration of the lumbo-sacral intervertebral disk and a subluxation of its corresponding facets (Fig 8)

SPONDYLOLISTHESIS

Spondylolisthesis was found in 3.75 per cent of the cases in this series. Its occurrence was practically the same in both sexes.

This lesion may cause symptoms at any age period after infancy. The clinical findings vary widely with individuals, depending to a large extent on the amount of forward displacement. Segmental pain is not a predominant finding in these cases, pain in the lower part of the back radiating through to the abdomen, the anterior upper thigh, and the groin is a more common finding. Symptoms of this lesion may be mistaken for appendicitis or a pelvic disorder.

The x-rays show a bilateral break in the bony continuity of the pedicle of the fifth lumbar vertebra and in most cases a varying degree of forward displacement of the lumbar spine on the first sacral table (Fig 7). In rare cases the forward displacement may progress to the extent that the lumbar spine descends in front of the sacrum. Occasionally a similar lesion involving the fourth lumbar vertebra may be observed.



Fig 6 Lumbarization of first sacral vertebra showing degenerative arthritic changes of rudimentary superior second sacral facet

FACET FRAGMENTATION AND ANOMALIES

Facet fragmentation and anomalies were found in 2 per cent of the cases in this series.

There is always considerable question whether a break in the bony continuity of a facet is the result of trauma or altered development. Mitchell has considered such lesions as fractures, while Nichols and Shiflett have referred to them as ununited anomalous epiphyses. The author favors the opinion of Mensor who believes that the majority of such lesions are fractures but that a developmental failure of fusion accounts for the lesser percentage.

The clinical findings are localized pain with its accompanying changes and frequently segmental symptoms involving the distribution of the nerve which emerges at the site of change. A loss of both motor and sensory function of the fifth lumbar nerve on the affected side was observed by the author in such a case. The history,

A STUDY OF THE EFFECT OF THORIUM DIOXIDE SOL INJECTED IN RABBITS

By CLIFFORD R ORR, M D, Roentgenologist, GEORGE D POPOFF, M D,
Asst Roentgenologist, RAYMOND S ROSEDALE, M D, Pathologist, and
BIRD R STEPHENSON, Ph D, Physicist, Buffalo, N Y

From the Buffalo City Hospital

THE large number of recent contributions to the literature suggesting the use of radio-active substances as a diagnostic method—such as hepato-angiography, arteriography—and as a therapeutic measure, has prompted the present investigation. Following the unpublished work of C R Orr and B R Stephenson, of our laboratories, who, in 1932, were successful in producing shadowgrams with a section of liver from a patient injected with thorium dioxide sol, we set about determining the latent effects of this radio-active material. Two methods of approach were used. (1) experimental animals were injected with the sol and detailed microscopic examinations made of the reticulo endothelial structure after

periods of from 24 hours to 385 days, and (2) roentgen films were exposed to prepared ampules of the sol, to dried specimens of the liver and spleen, and to histological sections in an effort to demonstrate radio-activity. We wish to add our findings to those of the increasing group of workers who believe that the use of radio-active salts, particularly the thorium preparations, is fraught with grave danger.

RADIO-ACTIVITY

Thorium is a well-known radio-active element which disintegrates slowly (22), taking several years to reach equilibrium with its disintegration products (Fig 1). When thorium preparations are first made

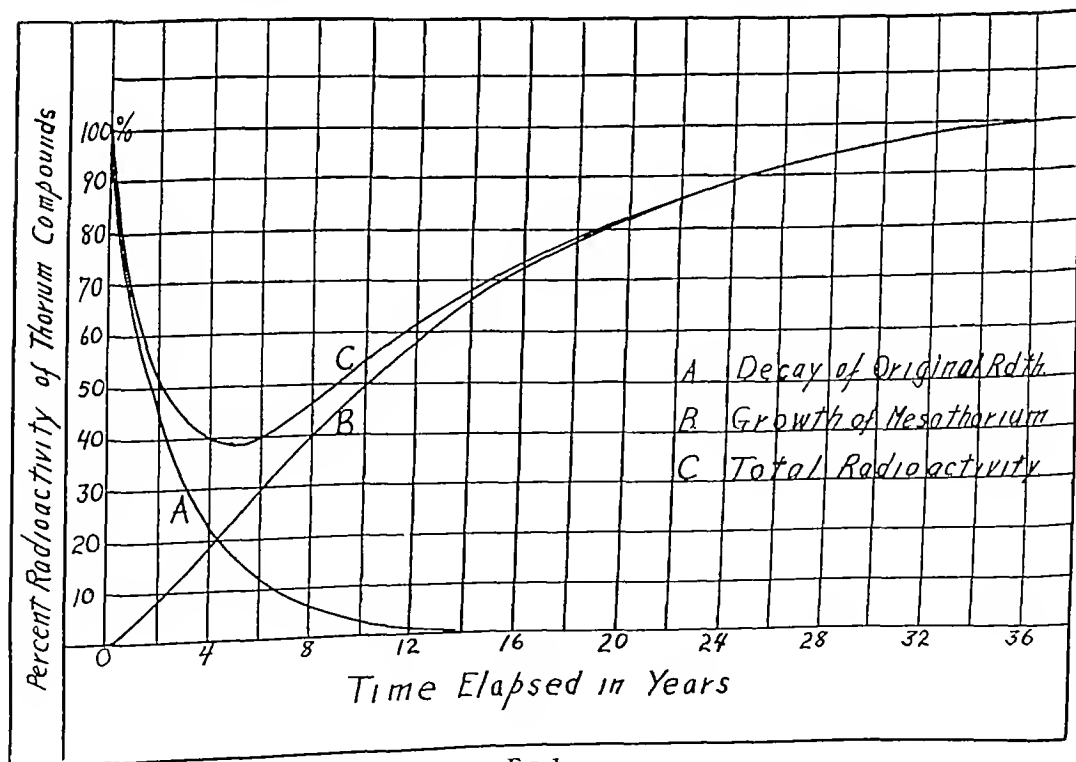


Fig 1
370

with a destruction of the lumbo-sacral disk it plays a definite rôle. When there is a well formed spinous process of the first sacral segment the descent of the fifth lumbar vertebra and the overriding of the lumbo-sacral facets are stopped by the contact of the spinous processes of the two vertebrae. In the absence of a well formed first sacral spinous process the descent may continue until the first sacral facets lodge in the inferior vertebral notch. The latter results in sclerosis and occasionally spur formation at this site. This is due to the fact that the first sacral facets have been converted into weight-bearing structures. This change can be observed in anteroposterior stereoscopic studies and occasionally is misinterpreted as a break in the bony continuity. Such spurs attached to the inferior vertebral notch of the fifth lumbar vertebra have been observed by the author in three postmortem studies (Fig 9).

Positional asymmetry of the first sacral facets is a common anomaly of the lumbo-sacral spine. The articular surface of one facet may be in the anteroposterior plane while that of the other may be in the transverse or oblique plane. The mechanical disadvantage resulting from such a variation undoubtedly hastens a degenerative change of the facet articulations. In the author's opinion, however, such an anomaly in itself is not productive of significant clinical symptoms. When observed in the x-ray film of a patient suffering symptoms characteristic of this group there are usually associated a settling of the lumbo-sacral intervertebral disk and an overriding of the facets.

It is not the purpose of this paper to discuss treatment, however, in planning such the importance of carefully posed and thoroughly studied x-ray films cannot be over-emphasized. The same is true of the clinical examination and observation. A hasty decision to fuse the anomalous lumbo sacral spine frequently results in an unjust criticism of the procedure. Treatment both surgical and non-surgical should be directed at widening the constricted foramina and putting to rest joints which



Fig 9 The descent of the fifth lumbar vertebra is occasionally stopped by the first sacral facet which lodges in the inferior vertebral notch. This in turn causes scarring and spur formation at this site.

have undergone a degenerative change. The former is as important as the latter in the author's opinion.

BIBLIOGRAPHY

- FOERSTER O. The Dermatomes in Man. Brain, March 1933 56, 1-30.
 MENSOR M C. Injuries to the Accessory Process of the Spinal Vertebrae. Jour Bone and Joint Surg April 1937 19, 381-388.
 MITCHELL C L. Isolated Fractures of the Articular Processes of the Lumbar Vertebrae. Jour Bone and Joint Surg July 1933 15, 608-614.
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 SCHMORL and JUNGHAANS. Die Gesunde und Kranke Wirbelsäule am Röntgenbild p. 175.
 WAGNER L C. Congenital Defects of the Lumbo-sacral Joints with Associated Nerve Symptoms. Study of 12 Different Types with Operative Repair. Am Jour Surg, February 1935 27, 311-327.

there might be some latent effects from the use of thorium preparations. Eriksen and Rigler (38), while admitting that there might be some possible harm due to long storage, yet believed that thorium is eliminated sufficiently to be used in safety. Robins and Goldberg (39) and Allen and Camp (40) also admitted the possibility of future damage but could find no definite indications of harmful effects. Huguenin and Neimours (41) suggested it might cause some hepatic insufficiency. Ucke (42) believed that blockage by thorium sol might impair the immunizing processes of the endothelial system, while Bauke and Koch (43) and Bucky and Leitner (44) showed by experiments that the phagocytosing ability is measurably decreased in injected rabbits. Ehrhardt (45) found that injected mice did not become pregnant, while Kadrnka (46), on the contrary, found that guinea pigs heavily injected bore normally developed living young. Menville and Ané (47) and Naegeli and Laeche (48) suggest waiting for further study. Rigler, Koucky, and Abraham (49), Kadrnka (46), Cooke (50), Pohle and Ritchie (51), Contiades, Naulleau, and Unger (52), and Capocaecia and Vallebona (53) recommend that, because of the possible damage to the reticulo-endothelial system due to delayed reaction, the use of thorium dioxide sol be limited to aged patients and hopeless cases. Hirsh and Morton (54) placed sections of liver and spleen over films, but were unable to find any trace of radio-activity up to four weeks' exposure, in spite of this they advised the restriction of its use to old persons, or to hopeless cases. Lewisohn (55), Lambin (56, 57), Whitaker, Davie, and Murgatroyd (58), and Vajano (59) all mention the slow elimination of the thorium dioxide sol with its possible delayed results, while Popper and Klein (60) because of the delayed activity, do not accept this method for routine work.

Of those who have opposed the use of radio-active material for injection into the

body, Martland (61, 79) was the first to point out that even very small doses retained in the body over a period of years may cause serious damage. Stewart, Einhorn, and Illick (62) were the first to obtain shadowgrams by placing the spleen from an autopsied case over a photographic plate. They declared that, in view of the possible danger, the injection of thorium does not give enough independent information to justify its use. Büngeler and Krautwig (63), after a critical analysis, warned that the substance should not be used in human beings, but should remain limited to animal experiments. Buchner (64), Anders and Leitner (65), Leitner (66), and Shute and Davis (67), after careful histological studies, cautioned against its use in human subjects. The Council of Pharmacy and Chemistry of the American Medical Association (68), in 1932, voted that thorium dioxide sol be not accepted for intravenous administration. Pearse (69), in discussing the work of Warren and Oehlbeck (70), stated that the autopsied liver and spleen of animals injected one year previously fogged a film after several days' exposure. In the latter part of 1936 several authors opposed the use of this preparation for injections. Fleming and Chase (71) were the first to obtain shadowgrams of histological sections from an autopsy liver specimen. They advised against the use of thorium dioxide sol in patients if the expectancy of life is more than two years. Taft (72, 73) measured the radio-activity of the product and warned against its use, inasmuch as the radio-activity was equivalent to that which Martland had found to be dangerous. Selbie (74) and Roussy, Oberling, and Guérin (75) also counselled against its use, since they found that it produced sarcomas in experimental rats and mice. Evans (76, 77), after measuring the activity of thorium dioxide sol, stated that the increasing alpha-ray activity of the mesothorium formed would probably prove dangerous to the patient after several years. Finally, the French committee composed of Duval,

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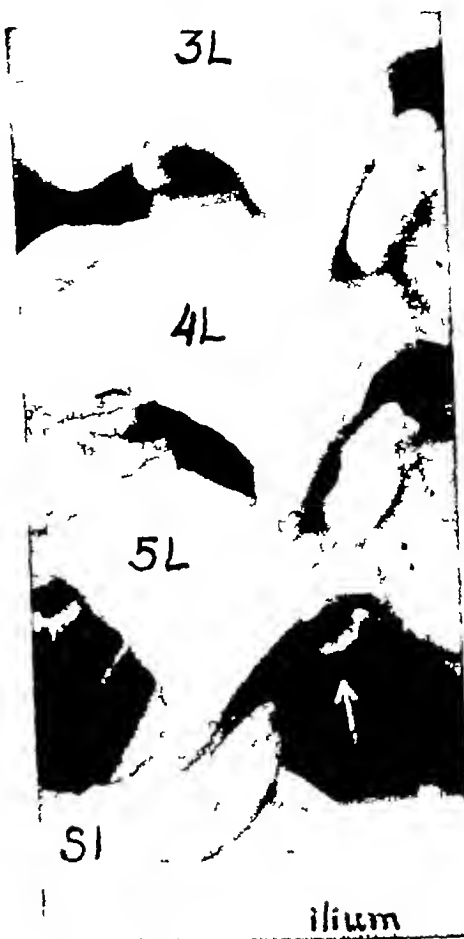


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BIBLIOGRAPHY

- FOERSTER, O. The Dermatomes in Man. Brain, March 1933 56, 1-39.
- MENSOR, M. C. Injuries to the Accessory Process of the Spinal Vertebrae. Jour. Bone and Joint Surg., April 1937, 19, 381-388.
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- NICHOLS, B. H. and SHIPLETT, E. L. Ununited Anomalous Epiphyses of the Inferior Articular Processes of the Lumbar Vertebrae. Jour. Bone and Joint Surg., July 1933 15, 591-600.
- SCHMORL and JUNGHAANS. Die Gesunde und Kranke Wirbelsäule am Röntgenbild. p. 175.
- WAGNER, L. C. Congenital Defects of the Lumbo-sacral Joints with Associated Nerve Symptoms. Study of 12 Different Types with Operative Repair. Am. Jour. Surg. February, 1935 27, 311-327.

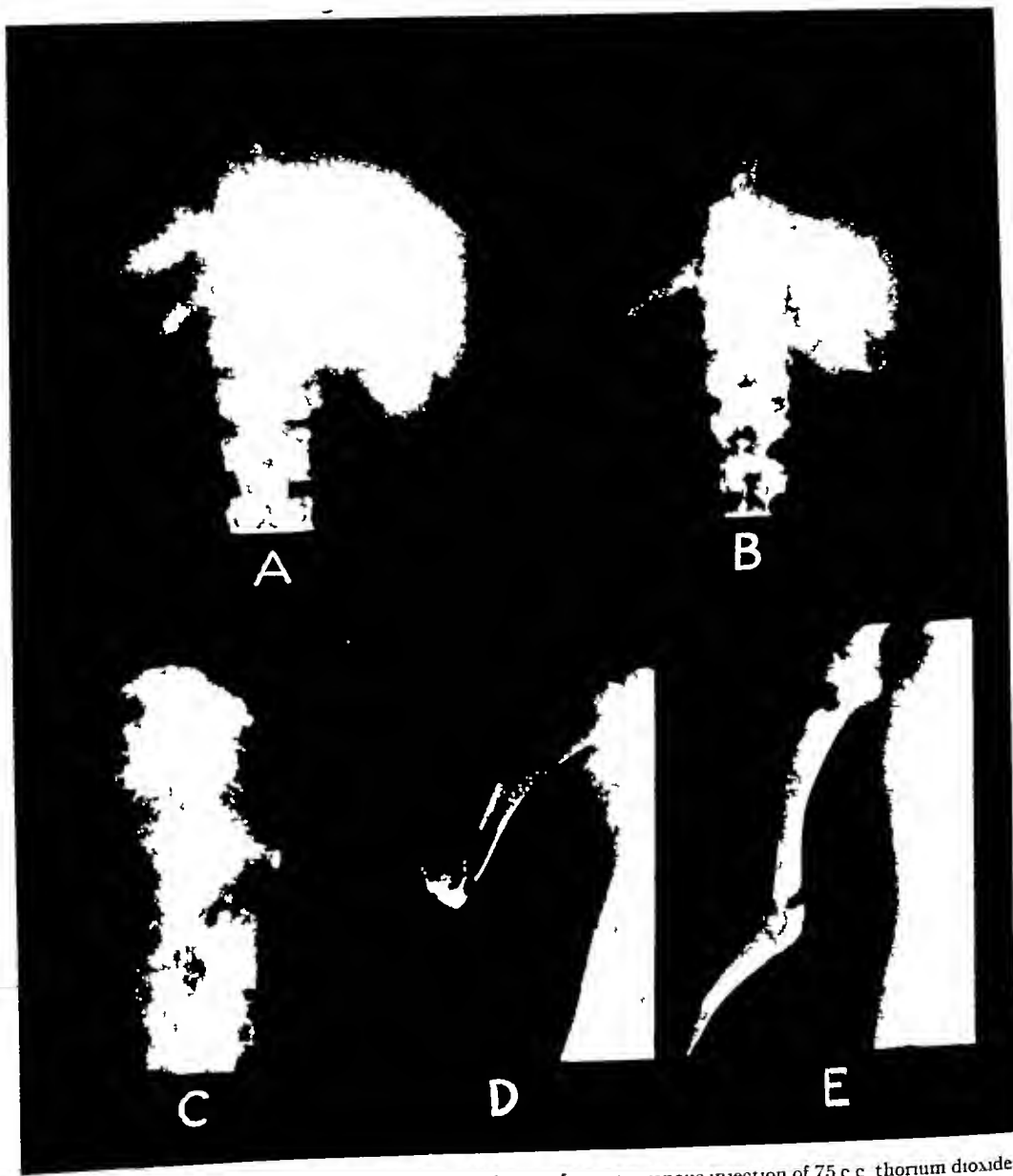


Fig 2 A Roentgenogram of a patient taken 24 hours after intravenous injection of 75 c c thorium dioxide sol
 Fig 2 B Roentgenogram of same patient taken four years later Note liver markedly decreased in size and increased in density also the peculiar concentration of the thorium in the hepatic trinity Spleen shows no change in density
 Fig 2 C Roentgenogram of rabbit No 16 two and one half years after intravenous injection 1.2 c c per kilogram body weight Note granular appearance of liver and spleen due to thorium concentration
 Figs 2 D-E Roentgenograms of humerus of rabbit No 13 (D) control and No 14 (E) three months after intravenous injection Note the increased density of bone marrow (E) as compared with normal homogeneous density (D)

in the liver, spleen, and bone marrow, and that there is apparently no real elimination of the drug

Changes in the body weight of the

injected animals and in the weights of liver and spleen as compared to those of uninjected animals were quite marked

Rabbit No 3 lost 25 per cent of its original

they are free of these products, with the exception of radiothorium. It will be observed in Figure 1 that the original radiothorium has practically disappeared at the end of 12 years and that the total radio-activity is at a minimum at the end of five years. From this point on the activity again increases, attaining a value of 54 per cent of the maximum in ten years and of nearly 90 per cent at the end of 25 years.

Applying the above known facts concerning thorium to the thorium dioxide sol, Schlund (22) found by measurement that one ampule of the freshly prepared sol radiates as many alpha particles per second as one microgram of radium, thus the alpha-ray activity of three ampules (the average human dose) is equivalent to three micrograms of radium. He stated, however, that if the sol is prepared from thorium nitrate which has aged five years, when the activity is at a minimum, it will contain only half this amount, or the equivalent of 1.5 micrograms of radium.

Taft (72, 73) reported a method of determining the radio-activity of a dose of thorium dioxide sol in the patient's body and found it to give off gamma rays equivalent to 1.37 microgram of radium.

Small as this may seem," he states, it is the amount found in the bodies of the girls who died of radium poisoning contracted when they painted radium on watch dials, and those who use it are on dangerous ground."

The Radium Institute of the Academy of Freiburg, according to Kadrnka (46), investigated the activity of 100 cc of thorium dioxide sol and found it to have a radio-activity equivalent to 1.24 microgram of radium.

Warren and his co-workers (69, 70) found that 75 cc of thorium dioxide sol is equivalent to 0.8 microgram of radium, while the alpha-ray activity is equal to 1.5 to 3 micrograms of radium. The latter is very important because of the intimate relation between the thorium and the tissue cells in the body.

Evans (77) on Nov. 2, 1936, carried out for us an analysis on a 25 cc commercially prepared sample of thorium dioxide sol and found it had a "gamma-ray activity equivalent to 0.25 microgram of radium when both the sol and radium gamma-ray measurements are made with 10 mm of lead filtration." He believed also that the "alpha-ray effects produced in patients over a period of from five to ten years may be more serious than early gamma-ray measurements might indicate."

REVIEW OF THE LITERATURE

Following the work of Oka (1) and Radt (2, 3), many investigators have carried out more or less extensive experiments on animals, while hundreds of patients have been injected with the thorium dioxide sol for diagnostic purposes. The bibliography of 79 papers here assembled is still only a partial list of all those published on this subject. In reading this literature one becomes aware of the tendency to emphasize the tremendous benefits achieved by the use of the sol as an ideal contrast medium and to minimize its ill effects, particularly those of delayed radio-activity. There are relatively few articles which state that the use of the preparation is definitely dangerous, and should not be used, therefore, in human beings.

The first 36 articles listed in the bibliography all favor the use of thorium dioxide sol, and make very little mention of any possible danger. Many of these articles, it is true, refer to its use in arteriography in which case the dose is relatively small.

Yater and Otell (13), who are widely quoted regarding the harmlessness of thorium dioxide sol, stated that the Bureau of Standards "showed that the radio-activity of thorium dioxide sol is negligible." This was unfortunate, for the Bureau later stated (37) that their earlier tests were informal and that they had not studied this problem sufficiently to make any definite statement.

Another group of writers suggested that

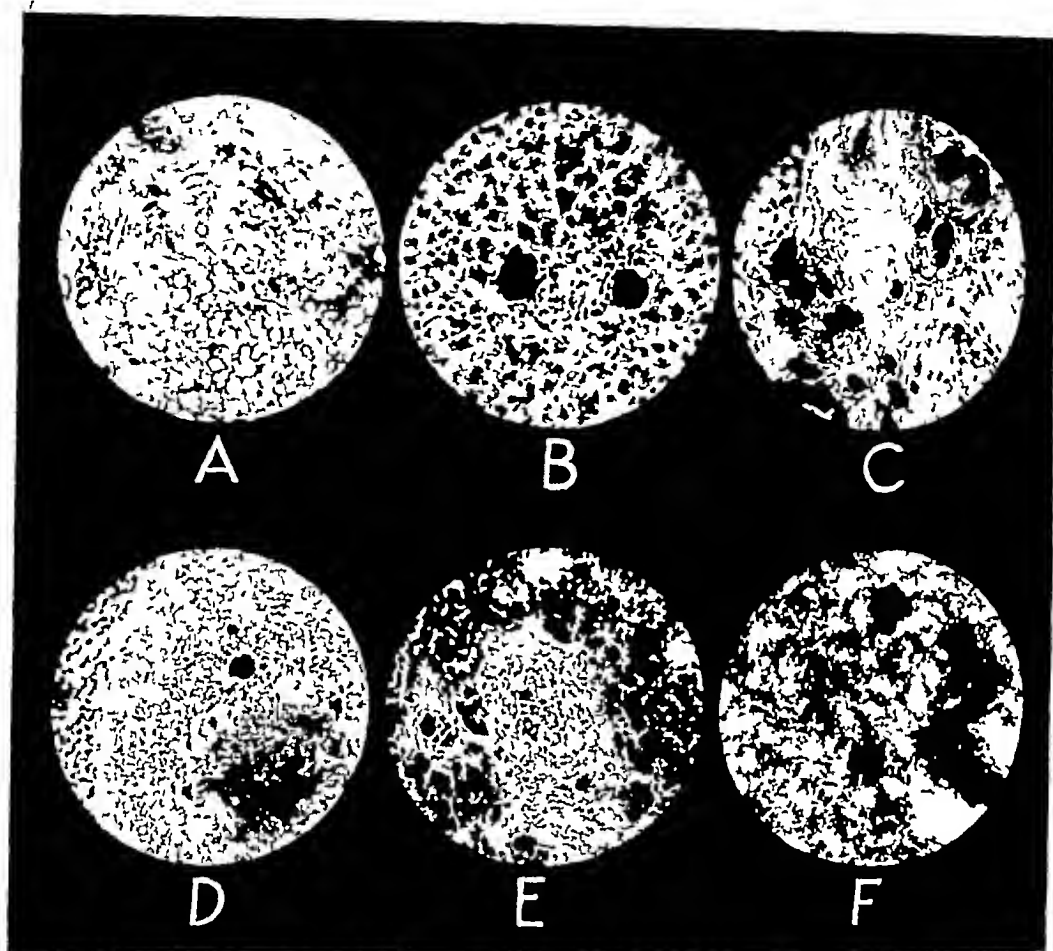


Fig 3-A Photomicroscopic section of liver (150 \times) rabbit No 9 injected intraperitoneally with 8 c.c. of thorium dioxide sol 12 months previously. Note accumulation of dark masses (thorium) increase in fat, and slight interlobular increase of fibrous connective tissue.

Fig 3-B Photomicroscopic section of liver (450 \times) rabbit No 3, injected with 4.4 c.c. per kilogram body weight, four and one half months before. Note the maturing granulation tissue about thorium dioxide masses. There is degeneration of some adjacent liver cells and hyperplasia of others.

Fig 3-C Photomicroscopic section of liver (250 \times) rabbit No 6. Note aggregates of dark gray globules (thorium). There is very definite proliferation of fibrous connective tissue and a slight lymphocytic infiltration about the hepatic triad. There is a hyperplasia of some hepatic cells at the periphery of lobules.

Fig 3-D Photomicroscopic section of liver (250 \times) rabbit No 14 three months after intravenous injection of 4.4 c.c. per kilogram body weight. Note the large area of focal necrosis surrounded by well defined exudative inflammation which is in turn flanked by early productive inflammation.

Fig 3-E Photomicroscopic section of spleen (250 \times) rabbit No 14. Note the dark gray irregular aggregates of thorium dioxide. The periphery of lymphoid follicles is degenerated and the central portions are hyperplastic. There is a slight amount of fibrosis.

Fig 3-F Photomicroscopic section of bone marrow of femur (150 \times) rabbit No 6. Note the large and small dark masses of thorium and hemopoietic inactivity.

surface of the liver. The peritoneum both parietal and visceral, was distended with large collections of thorium. The subserosa and voluntary muscles contained large, irregularly shaped phagocytic cells whose cytoplasm was laden with amorphous material of the same appear-

ance. The nuclei of such cells were poorly differentiated.

Bone Marrow—Rabbit No 6 (Fig 3-F) The bone marrow contained collections of round and ovoid highly refractile violaceous bodies which appeared to be in the thin-walled sinusoids. There were

TABLE I—DATA ON RABBITS INJECTED WITH THORIUM DIOXIDE SOL

Rabbit Number	Weight (gm)	Wt at Death (gm)	Date Inj	Total (cc)	Amount Injected cc per kg	Place Administered	Manner of Death	Time after Inj	Wt of Spleen (gm)	Vol of Spleen (cc)	Wt of Liver (gm)	Vol. of Liver (cc)
12	2 200		12/4/34	2 5	1 1	Intravenous	Killed	24 hours	1 2	1 1		
11	2,200			0	0	0	Killed	24 hours	0 793	0 9		
16	1,900	1,585	12/4/34	2 25	1 2	Intravenous	Nat	33 mos	0 533		40	
15	1 900			0	0	0	Nat	4 mos				
3	3,600	2 700	6/12/34	16	4 4	Intravenous	Nat	4 5 mos				
14	2 640	2,500	12/4/34	12	4 4	Intravenous	Nat	3 mos	3 678	2 7	96	91
13	2 640	2 950		0	0	0	Killed	3 mos	1 58	1 5	87	82
6			7/7/34	20		Intraperitoneally	Nat	14 6 mos				
9			8/22/34	8				1 year				
5	2 270		7/20/34	20	8 8	Intra-intestinally						

Regaud, Rouhier, Bazy, and B  cl  re (78) recommended that radio-active substances be completely abandoned in therapeutic injections

EXPERIMENTAL DATA

The purpose of the investigation with thorium dioxide sol was to determine (1) The site of storage, (2) The delayed effect on body tissue, (3) The degree of radio-activity, (4) The rate of elimination, (5) The route of elimination

Three groups of rabbits, varying from 2 to 4 kgm in weight, were injected The usual method was to inject three equal fractional doses on succeeding days Rabbits No 12 and No 16 received intravenously a total dose of 1 1 and 1 2 cc per kgm body weight, respectively, the controls, No 11 and No 15, received none The second group, No 3 and No 14, received intravenously 4 4 cc per kgm body weight, rabbit No 13 was the control The third group, No 6 and No 9, received intraperitoneally 20 cc and 8 cc, respectively Rabbit No 5 received by accident 20 cc intra-intestinally Table I contains a complete summary of the doses, weights, and other pertinent data

The animals were maintained on the same diet throughout the entire experiment Roentgenograms were then taken at intervals, employing a constant technic of 50 kv, 100 ma, 30 in distance, 1/120 sec exposure

RADIOLOGICAL FINDINGS

The roentgenograms of rabbit No 16 (Fig 2-C) taken two and one-half years after injection, showed no change in the density of the liver and spleen as compared with roentgenograms taken immediately after injection Roentgenograms of the humerus of No 14 (Fig 2-E), taken three months following injection, showed a marked increase in density of the medullary canal as compared with roentgenograms of the control No 13 (Fig 2-D)

Roentgenograms of No 6, which received 20 cc intraperitoneally, showed the peritoneal, diaphragmatic, and sub-sternal lymph channels packed with thorium

Roentgenograms of No 5, which unintentionally received 20 cc intra-intestinally, taken one-half hour, 20 hours, and six days, respectively, following injection, revealed that all the material had been eliminated from the intestinal tract The increased density of the spleen indicated, however, that some of the thorium had been absorbed and stored in the reticulo-endothelial system

The comparative roentgenograms (Figs 2-A and 2-B) of a patient injected May 10, 1933, exhibited no change in density of the liver and spleen after a period of four years

The results of these roentgenographic studies confirm those of many authors in demonstrating that the thorium is stored

None of the controls showed any abnormalities whatsoever

The histological findings here reported are practically identical with those reported by Whitaker, Davie, and Murgatroyd (58)

RADIO-ACTIVITY

As previously stated, Prof R D Evans measured for us the radio-activity of an ampule of thorium dioxide sol and found it to be equivalent to 0.25 microgram of radium when measured through 10 mm of lead

Rabbit No 12, which received approximately 10 per cent of one ampule, was taken to Cambridge, Aug 27, 1937, where the radio-activity of the live rabbit was measured by Professor Evans. The rabbit died the following day. An autopsy was performed and the dried material sent to Professor Evans. Both the live rabbit and the dried material showed 50 ± 50 per cent retention. The large uncertainty is due to the fact that the 0.025 microgram of radio-active material injected approaches the lowest limit that can be detected by gamma-ray measurements

The radio-activity of the sol and of injected specimens was demonstrated in this laboratory by means of photographic films and the spintharoscope

Roentgen films were exposed to a commercial ampule of the sol, after eight days there was a marked fogging on the emulsion, the shadow clearly outlining the ampule

The liver and spleen of rabbit No 3 were dried and placed directly over a film with lead strips interposed between the film and the specimens to produce contrast. Distinct shadows were produced by exposures ranging from 45 days down to two hours (Figs 4-A, 4-B, 4-C), and a faint shadow was also obtained in only one hour. These pictures, after Martland (79), are called "shadowgrams." The lungs (Fig 4-G) and the femur (Fig 4-H) of rabbit No 14 also gave definite shadowgrams

To eliminate the alpha radiation, dental ocellular films in their original covers were exposed to the same specimens. Intense shadowgrams were obtained after five days' exposure

The relative strength of the penetrative radiation was demonstrated by placing aluminum filters ranging in thickness from 0.3 mm to 2 mm between the specimens and the films. Definite shadowgrams were obtained with 0.3, 0.5, and 1 mm of aluminum in two days and with 2 mm of aluminum in 20 days (Figs 4-D, 4-E, and 4-F)

Histologic sections of the liver of No 3 and the spleen of No 14, ten micra thick, were deparaffinized and dried on slides. Fast panchromatic films were exposed to these slides and after 90 hours definite histoshadowgrams were obtained (Figs 4-I and 4-J)

The presence of alpha radiation was demonstrated by placing a small bit of the dried spleen of No 3 in a spintharoscope. The large number of scintillations produced on the screen demonstrated clearly the presence of alpha particles

It is thus evident that if there is sufficient radio-activity to produce the above effects, then this radio-activity would produce a continuous bombardment of the cells in the body tissues wherein it became lodged

SUMMARY

1. Injected thorium is engulfed by the reticulo-endothelial system, i.e., the reticulum cells of the splenic pulp, lymphatic tissue, and bone marrow, the endothelial cells of the liver capillaries (Kupffer cells), lymph sinuses, splenic sinuses, bone marrow, and suprarenal capillaries, and the phagocytic cells in connective tissue

2. There has been no evidence of elimination of this substance from the body during a four-year period of observation. This apparently results in a permanent blockage of the reticulo-endothelial system, and may thus impair its immunologic properties

weight in a period of four and one-half months, a portion of which was undoubtedly due to an abortion of eight dead young two weeks after injection. No 14 lost 140 grams after three months, while the control, No 13, gained 310 grams. No 16, which received a minimal dose, gained a maximum of 150 grams after two and one-half years and then lost 465 grams in the three months preceding death. These data would indicate that thorium dioxide sol so disturbed the body functions as to inhibit normal growth and nutrition.

The spleen of animal No 12 increased both in weight and volume markedly over the control No 11 after only 24 hours. It is to be noted that this was after injection of the minimal dose. The spleen and liver of No 14, which was given a larger dose, showed a much greater increase over the control, the spleen being 130 per cent greater in weight and 80 per cent in volume, while the liver increased 10 per cent in weight and 11 per cent in volume.

From these data it would appear that, in spite of the loss of total body weight as compared to the control, the liver and spleen immobilized sufficient thorium to enlarge greatly both their relative and absolute weights and volumes.

PATHOLOGICAL FINDINGS, MICROSCOPIC

Liver—The Kupffer cells in rabbit No 12, which received the minimal dose, had engulfed the thorium, and the capillaries were hemorrhagically congested. Additional findings in a section of No 9 (Fig 3-4) were pronounced fat vacuolization especially at the periphery of the lobules. The fibrous tissue septa were increased in size and contained thorium.

Sections of No 3 (Fig 3-B) which received a larger dose, showed a small amount of lymphatic infiltration of some of the bile ducts. Throughout the entire section there were numerous areas of healing focal central necrosis, filled with large masses of thorium surrounded by a moderate amount of pink-stained col-

lagenous fibers in which the nuclei, for the most part, were hyperplastic, ovoid, and pear-shaped. The adjacent hepatic cells presented two appearances: in the one group the cytoplasm was poorly defined and the nuclei were karyolytic, in the other group, which is the predominant one, the cells were larger than normal, well defined, and had prominent hyperchromatic nuclei.

In sections of No 6 (Fig 3-C) there was a definite increase of the fibrous connective tissue over that observed with smaller doses. One very distinct area of focal necrosis was seen deep within the liver substance. It was characterized by the deeper pink-staining cytoplasm of the involved cells, distinct karyolysis, pyknosis, and complete loss of outline of the nuclei. In other nuclei karyorrhexis was seen. The damaged cells contained thorium.

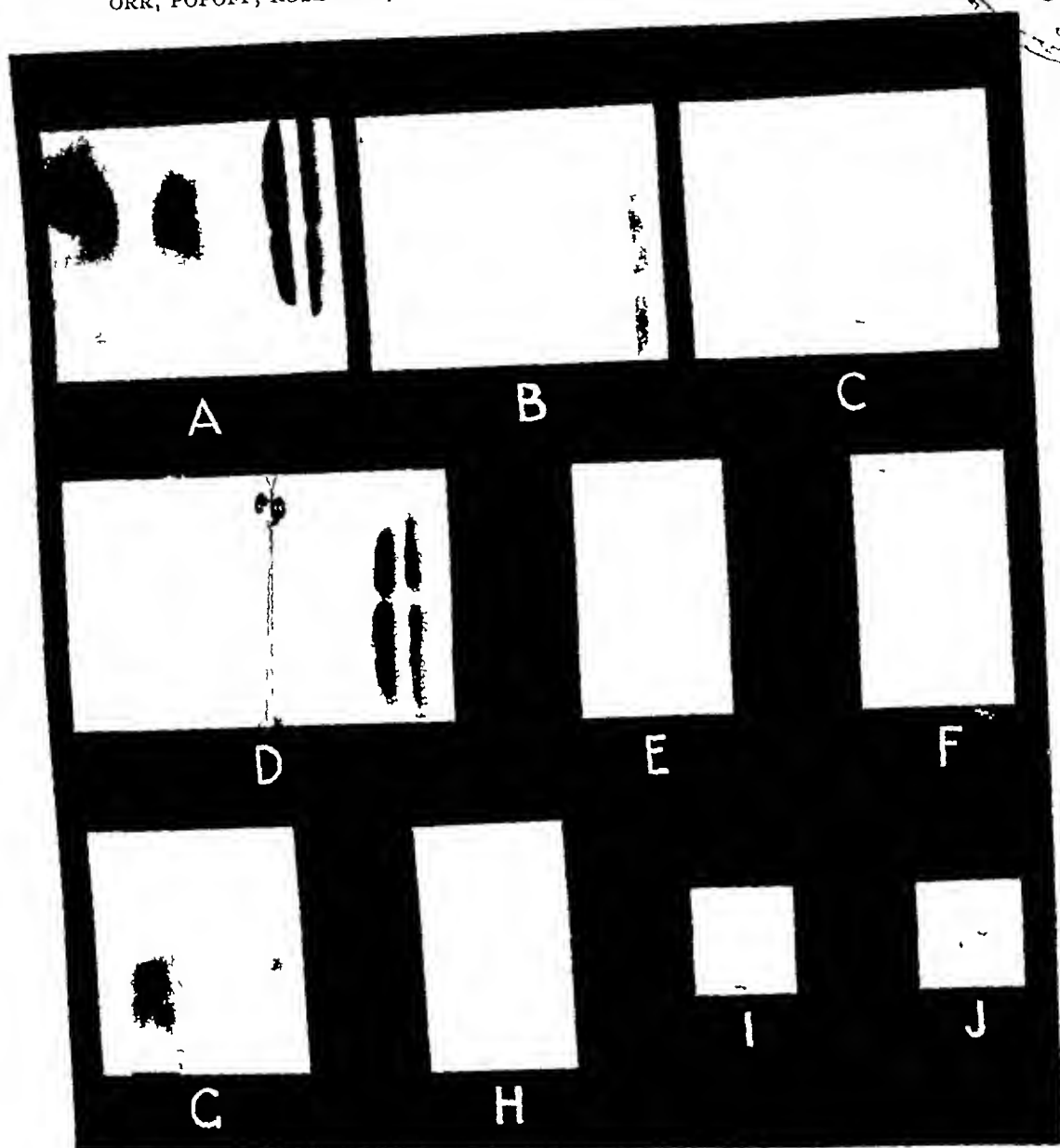
The section of No 14 (Fig 3-D) showed, in addition to many of the above characteristics, multiple areas of necrosis. There was a distinct increase in periportal connective tissue.

Spleen—Sections of the spleen of No 12 and No 9, which received comparatively small doses, showed hemorrhagic congestion throughout the red pulp with the lymph venous sinuses largely filled with thorium. The periphery of the lymph follicles contained shiny refractile, brown violaceous staining granules indicating thorium. In relation to these there were large phagocytic cells, whose cytoplasm was laden with material of the same appearance.

In No 14, (Fig 3-E), which received a much larger dose, the only additional change noticed was an almost complete replacement of the tissue by the irregularly shaped large masses, which were presumably thorium.

Abdomen—The abdomen showed no changes, except in rabbit No 6 which had received a large dose intraperitoneally. The organs grossly were not remarkable, except for the presence of tiny yellow-gray points just discernible on the cut

- Spleen in the Human. *Am Jour Roentgenol and Rad Ther* February 1932, 17, 265, 266
- (20) HUGUENIN R, NEMOURS AUGUSTE and ALBOT, G. Les Hépates et les Cirrhoses Experimentales au Bioxide de Thorium. *Compt rend Soc de biol Dec 4, 1931* 103, 579-581
- (21) SELDENFELD G A. Zur Frage der pathologischen Veränderungen der Gefäße bei Vasographie mittels Thorotrast. *Arch f klin Chir*, 1930 185, 209-307
- (22) SCHLUND H. Report to the Heyden Chemical Corporation 50 Union Sq New York City June 13, 1932
- (23) MINNELL T O and MILLER J D. Recent Advances in Hystero-graphy. *Am Jour Obst and Gynec* October 1933 30, 790-795
- (24) SAITO MOKOTO. Normal Shadow of the Peripheral Nerves and Their Pathological Changes in Injury and Tumor. *Roentgenological Studies by Means of Thorium Dioxide Solution (Thorotrast)*. *Am Jour Surg* November 1931 26, 300-316
- (25) HICKIN N I, BIST R R, MOON C I, HARRIS, F T. The Pre-operative Visualization of Breast Tumors. *Jour Am Med Assn*, March 13, 1937 103, 864-867
- (26) FREDMAN W, SCHOLFIELD H H and MOORE, C. Ventrulography with Colloid of Thorium Dioxide. *Jour Am Med Assn* June 11 1936 106, 96-101
- (27) ALEXANDER I, JENKINS T S and LAMAN R S. Colloidal Thorium Dioxide. Its Use in Intracranial Diagnosis and its Fate on Direct Injection into the Brain and the Ventricks. *Arch Neurol and Psychiat*, December 1931 32, 1143-1158
- (28) LEAS, MONIE. Cerebral Angiography with Thorotrast. *Arch Neurol and Psychiat* June 1933, 29, 1318-1323
- (29) VIAL J R and McLETRIDCH E M. Arteriography in Gangrene of Extremities by the Use of Thorium Dioxide. *Ann Surg* February 1935 101, 766-775
- (30) ALLEN E V and CAMM J D. The Value of Arteriography. *RADIOLOGY* June 1931 22, 678-683
- (31) HECKMAN K, and ALTENBURGER I. Ueber eine Methode zur Untersuchung des subphrenischen Abszesses und seiner Ausdehnung durch Einspritzung von Thorotrast. *München med Wehnschr* Nov 5 1935 82, 1800-1802
- (32) KNAPP, J C. Arteriography. New York St Jour Med Jan 15 1935 35, 76-78
- (33) YETTER W M. A Study of Four Cases of Acquired Arteriovenous Fistula by Means of Thorotrast Arteriography. *Ann Int Med* October 1936 10 466-480
- (34) Idem. Thorotrast Arteriography of the Extremities with Report of Illustrative and Unusual Cases. *Am Heart Jour* October 1936 12, 383-405
- (35) YATER W M, and OTELL L S. Hepatosplenography with Thorium Dioxide Sol. *Jour Am Med Assn* Aug 12 1933, 101, 507-514
- (36) TWining E W and ROWBOTHAM G F. Ventrulography by Opaque Injection. *Lancet* July 20 1935 2, 122-125
- (37) NATIONAL BUREAU OF STANDARDS. Personal communication
- (38) ERICKSEN L G and RIGLER L G. Roentgen Visualization of Liver and Spleen with Thorium Dioxide Sol with Particular Reference to Pre-operative Diagnosis of Carcinomatous Metastases to Liver. *Jour Am Med Assn* June 3 1933 100, 1753-1764
- (39) ROBINS SAMUEL A and GOLDBERG B I. Visualization of Reticulo-endothelial System by the Injection of Colloidal Thorium Dioxide (Thorotrast). An Experimental Study. *Am Jour Roentgenol and Rad Ther* October 1935 34, 433-450
- (40) ALLEN, E V and CAMP JOHN D. Arteriography. A Roentgenographic Study of the Peripheral Arteries of the Living Subject Following their Injection with Radiopaque Substance. *Jour Am Med Assn* Feb 23 1935, 104, 618-624
- (41) HUGUENIN R, and NEMOURS A. Arterio-hepato-splenography. Experimental Study by the Intravenous Injection of Thorium Dioxide (Thorotrast). *Rev de path comparee* 1931 31, 480-483
- (42) UCKE A. Ueber das Schicksal des Thoriums im Körper des Warmblüters bei intravenöser Verabfolgung von Thorotrast. *Blut z path Anat u z allg Path* 1935 96, 228-232
- (43) BAUER, C C and KOEN A. Immunbiologische Versuche zur Frage der Funktionsschädigung des Organismus nach Speicherung von Thoriumdioxidsol. *Deutsche med Wehnschr* Feb 8 1935 61, 211-213
- (44) BUCKY G and LEFFNER Z. Biologische Beobachtungen bei der Speicherung von Thoriumdioxidsol 1 Phagozytose. *Fortschr a d Geb d Roatgenstrahlen* May 1932 45, 561-565
- (45) ENHARDT K. Die roatgenologische Darstellung der placenta im Tierversperiment. *Klin Wehnschr* 1eb 20 1932, 11, 332 333
- (46) KADRYALA, SILVJE. Hepatosplenography. Roentgenologie. Demonstration of the Parenchyma of the Spleen and Liver by Means of a New Intravenous Contrast Medium (Thorotrast). *RADIOLOGY* February 1932 18, 371-377
- (47) MENVILLE L J and ANÉ J N. Roentgen Visualization of Lymph Nodes in Animals. *Jour Am Med Assn* May 21 1932, 98, 1790-1798
- (48) NYEGELI and LAUCHE. Ueber experimentelle und pathologisch anatomische untersuchungen bei Kontrastdarstellung der Milz und Leber [Abstract]. *Med Klin* December 1931, 27, 1878
- (49) RIGLER L G, KOVCKY R F, ABRAHAM, A L. The Effects of Thorium Dioxide Sol (Thorotrast) on the Human Liver. *RADIOLOGY* November 1933, 25, 321-331
- (50) COOK, H HAMILTON. Hepatosplenography. Experimental Study of the Elimination of the Contrast Medium. *Arch Surg* July 1934 29, 29-41
- (51) POULE E A and RITCHIE G. Histological Studies of the Liver and Spleen and Bone Marrow in Rabbits Following the Intravenous Injection of Thorium Dioxide. *Am Jour Roentgenol and Rad Ther* April 1934 21, 512-519
- (52) CONTADES X J, NAULLEAU J and UNGER G. Sur l'action vaso-motrice et les dangers des produits de contrast utilisés en arteriographie. *Recherches experimentales et résultats cliniques*. *Bull. et mem Soc nat de chir* Feb 16 1935 61, 187-198
- (53) CAPOCACCIA M and VALLEBONA A. Effects of Thorium Dioxide in Roentgenotherapy and Short Wave Therapy on Fixation in Liver and Spleen. *Radiol med* June 1936 23, 389-402
- (54) HIRSH J E and MORTON B F. Visualization of the Liver and Spleen as a Diagnostic Aid in Abdominal Conditions. *South Med Jour* August, 1934, 27, 683-690
- (55) LEWISOHN R. Hepato-splenography with Thorotrast. *Surg Gynec and Obst* July 1932 55, 68-73
- (56) LAMBIN P. Aspects Histologiques de la Fixation du Dioxide de Thorium dans les Organes. *Compt rend Soc de biol* Jan 15 1932 109, 66-69
- (57) Idem. Effets Tardifs des Injections de Dioxide de Thorium. *Compt rend Soc de biol* Oct 14 1932 111, 225-227
- (58) WHITAKER P H, DAVIS T B and MURGA TROYD F. Hepato-splenography by the Aid of Thorotrast—Its Uses and Dangers. *Quart Jour Med* January 1933 2, 49-58
- (59) VAJANO D. Action of Thorium Dioxide Intravenous Injections in Hepato-splenography. Radiologic and Histologic Study of Rabbits and Guinea Pigs Three Years after Administration of Preparation. *Arch di radiol* March April 1935 11, 127-142



Figs 4-A 4-B and 4-C Shadowgrams of liver and spleen rabbit No 3 X ray films exposed directly to dry specimens for 10 days 40 and eight hours respectively with interposed lead cross

Figs 4-D 4-E and 4-F Shadowgrams of same organs obtained through original wrapping plus 0.3 mm, 1 mm and 2 mm respectively aluminum filter in six, two and 20 days' exposure respectively

Fig 4-G Shadowgram of lung rabbit No 14, obtained in 60 days' exposure

Fig 4-H Shadowgram of femur rabbit No 14 obtained in 60 days' exposure

Figs 4-I and 4-J Histoshadowgrams of sections of liver and spleen 10 micra thick rabbits No 3 and No 14 respectively Supersensitive panchromatic film exposed to deparaffinized microscopic section for 90 hours

some phagocytic cells whose cytoplasm was loaded and distended with such granules, the nuclei being somewhat flattened

Lungs—The walls of the alveoli and interstitium contained masses of thorium engulfed by phagocytes. There was pro-

nounced edema but no inflammatory reaction

Adrenals—The adrenals contained thorium in the reticulo-endothelial cells. There was questionable degeneration of the cortical cells in the zona glomerulosa

- Spleen in the Human. *Am Jour Roentgenol and Rad Ther*, February, 1932 17, 265-266
- (20) HUGULIN R, NEMOURS AUGUSTE and ALBOT, G. Les Hépates et les Cirrhoses Experimentales au Bioxide de Thorium. *Compt rend Soc de biol* Dec 4, 1931 103, 879-881
- (21) SIEBELINOST, G. A. Zur Frage der pathologischen Veränderungen der Gefäße bei Vasographie mittels Thorotrast. *Arch f klin Chir*, 1936 185, 200-307
- (22) SCHLUND H. Report to the Hayden Chemical Corporation 50 Union Sq. New York City, June 13 1932
- (23) MENDES T O, and MILLER J D. Recent Advances in Hystorography. *Am Jour Obst and Gynec* October 1935, 30, 590-595
- (24) SAITO MOKOTO. Normal Shadow of the Peripheral Nerves and Their Pathological Changes in Injury and Tumor. Roentgenological Studies by Means of Thorium Dioxide Solution (Thorotrast). *Am Jour Surg*, November 1931 26, 300-316
- (25) HICKLEY N I, BIST R R, MOON C F, HARRIS T I. The Pre-operative Visualization of Breast Tumors. *Jour Am Med Assn* March 13, 1937 103, 804-807
- (26) IRLMAN, W, SCHOTENILLO H H and MOORE, C. Ventricleography with Colloidal Thorium Dioxide. *Jour Am Med Assn* Jan 11 1936 106, 96-101
- (27) ALEXANDER I, JUNG I S, and LAMIN R S. Colloidal Thorium Dioxide. Its Use in Intracranial Diagnosis and its Fate on Direct Injection into the Brain and the Ventricle. *Arch Neurol and Psychiat* December 1931 32, 1143-1155
- (28) LEIS MOXIZ. Cerebral Angiography with Thorotrast. *Arch Neurol and Psychiat* June, 1933 29, 1315-1323
- (29) VLAL J R and MCINTIRDOCE E M. Arteriography in Gangrene of Extremities by the Use of Thorium Dioxide. *Ann Surg*, February 1935 101, 766-775
- (30) ALLAN L V and CAMP J D. The Value of Arteriography. *RADIOLOGY* June 1934 22, 678-683
- (31) HECKMAN K. and ALTENBURGER E. Ueber eine Methode zur Untersuchung des subphrenischen Abszesses und seiner Anschnung durch Einspritzung von Thorotrast. *München med Wchenschr* Nov 8 1935 82, 1800-1802
- (32) KYPP J C. Arteriography. *New York St Jour Med* Jan 15 1935 35, 76-78
- (33) YATER W M. A Study of Four Cases of Acquired Arteriovenous Fistula by Means of Thorotrast Arteriography. *Ann Int Med* October 1936 10 466-480
- (34) Idem. Thorotrast Arteriography of the Extremities with Report of Illustrative and Unusual Cases. *Am Heart Jour*, October, 1936 12, 383-405
- (35) YATER W M and OTELL L S. Hepatosplenography with Thorium Dioxide Sol. *Jour Am Med Assn* Aug 12 1933 101, 507-514
- (36) TWING E W, and ROWBOTHAM G F. Ventricleography by Opaque Injection. *Lancet* July 20 1935 2, 122-125
- (37) NATIONAL BUREAU OF STANDARDS. Personal communication
- (38) ERICKSEN L G, and RIGLER L G. Roentgen Visualization of Liver and Spleen with Thorium Dioxide Sol with Particular Reference to Pre-operative Diagnosis of Carcinomatous Metastases to Liver. *Jour Am Med Assn* June 3, 1933 100, 1758-1764
- (39) ROBINS SAMUEL A and GOLDBERG B I. Visualization of Reticulo-endothelial System by the Injection of Colloidal Thorium Dioxide (Thorotrast). An Experimental Study. *Am Jour Roentgenol and Rad Ther* October 1935 34, 433-450
- (40) ALLEN E V and CAMP JOHN D. Arteriography. A Roentgenographic Study of the Peripheral Arteries of the Living Subject Following their Injection with Radiopaque Substance. *Jour Am Med Assn*, Feb 23 1935, 104, 618-624
- (41) HUGULIN R and NEMOURS A. Arteriohepatosplenography. Experimental Study by the Intravenous Injection of Thorium Dioxide (Thorotrast). *Rev de path comparee* 1931, 31, 480-483
- (42) UCKER, A. Ueber das Schicksal des Thoriums im Körper des Warmblüters bei intravenöser Verabfolgung von Thorotrast. *Beitr z path Anat u z allg Path* 1935 96, 228-232
- (43) BAUKE E E and KOCU A. Immunobiologische Versuche zur Frage der Funktionsschädigung des Organismus nach Speicherung von Thoriumdioxidsol. *Deutsche med Wchenschr* Feb 8, 1935 61, 211-213
- (44) BUCKA G and LLITNER Z. Biologische Beobachtungen bei der Speicherung von Thoriumdioxidsol. 1. Phagozytose. *Fortschr a d Geb d Rontgenstrahlen* May, 1932 45, 561-565
- (45) ENRIKHART K. Die roentgenologische Darstellung der placenta im Tierexperiment. *Klin Wchenschr* Feb 20 1932 11, 332-333
- (46) KADENKA, SILVIJE. Hepatosplenography. Roentgenologic Demonstration of the Parenchyma of the Spleen and Liver by Means of a New Intravenous Contrast Medium (Thorotrast). *RADIOLOGY*, February 1932 18, 371-377
- (47) MENVILL L J and ANÉ J N. Roentgen Visualization of Lymph Nodes in Animals. *Jour Am Med Assn* May 21 1932, 98, 1796-1798
- (48) NAEGLI and LAUCH. Ueber experimentelle und pathologisch anatomische Untersuchungen bei Kontrastdarstellung der Milz und Leber [Abstract]. *Med Klin* December 1931 27, 1878
- (49) RIGLER L G, KOUCKA R F, ABRAHAM A L. The Effects of Thorium Dioxide Sol (Thorotrast) on the Human Liver. *RADIOLOGY*, November, 1936, 25, 521-531
- (50) COOKE H, HAMILTON. Hepatosplenography. Experimental Study of the Elimination of the Contrast Medium. *Arch Surg* July 1934 29, 29-41
- (51) POULE E A and RITCHIE G. Histological Studies of the Liver and Spleen and Bone Marrow in Rabbits Following the Intravenous Injection of Thorium Dioxide. *Am Jour Roentgenol and Rad Ther*, April 1934 21, 512-519
- (52) CONTRADES X J, NAULLEAU J and UNGER, G. Sur l'action vaso-motrice et les dangers des produits de contrast utilisés en arteriographie. Recherches experimentales et resultats cliniques. *Bull cliem Soc nat de chir* Feb 16 1935 61, 187-198
- (53) CAPOCACCIA M and VALLEBONA A. Effects of Thorium Dioxide in Roentgenotherapy and Short Wave Therapy on Fixation in Liver and Spleen. *Radiol med* June 1936 23, 359-402
- (54) HIRSH J C and MORTON B F. Visualization of the Liver and Spleen as a Diagnostic Aid in Abdominal Conditions. *South Med Jour* August 1934, 27, 683-690
- (55) LEWISOHN R. Hepato-splenography with Thorotrast. *Surg Gynec and Obst* July 1932 55, 68-73
- (56) LAMBIN P. Aspects Histologiques de la Fixation du Dioxide de Thorium dans les Organes. *Compt rend Soc de biol* Jan 15 1932 109, 66-69
- (57) Idem. Effets Tardifs des Injections de Dioxide de Thorium. *Compt rend Soc de biol* Oct 14 1932 111, 225-227
- (58) WHITAKER P H, DAVIE T B and MURGATROUD F. Hepato-splenography by the Aid of Thorotrast—Its Uses and Dangers. *Quart Jour Med* January 1933 2, 49-58
- (59) VAJANO D. Action of Thorium Dioxide in Intravenous Injections in Hepatosplenography. Radiologic and Histologic Study of Rabbits and Guinea Pigs Three Years after Administration of Preparation. *Arch di radiol* March April 1935 11, 127-142

BIBLIOGRAPHY

3 Thorium dioxide sol has been demonstrated, by means of shadowgrams, to be definitely radio-active in both prepared ampules and when engulfed in body tissues. Even minute amounts of injected tissue have been shown to be radio-active by means of histoshadowgrams and by the spinthariscopes. The use of filters has shown that both alpha and gamma radiation are present.

4 The following histologic changes have invariably been found:

(a) The reticulo-endothelial system phagocytoses the thorium dioxide.

(b) The liver shows pathologic changes varying from simple cloudy swelling to profound necrosis, depending upon the dose. These changes are followed by fibrous tissue proliferation giving a picture similar to mild nodular hyperplastic cirrhosis.

(c) The spleen shows damage varying from degeneration of the lymph follicles to marked necrosis, even of the vessels and interstitium.

(d) The bone marrow contains large clusters of thorium and shows hematopoietic depression.

(e) The lung histocytes contain thorium with no definite tissue damage.

(f) The adrenals contain thorium in the reticulo-endothelial cells. There is questionable degeneration of the cortical cells in the zona glomerulosa.

CONCLUSIONS

We believe that thorium dioxide sol should not be injected into human beings because:

1 It is not eliminated from the body.
2 It apparently blockades the reticulo-endothelial system and may thus adversely affect some of the body's immunity mechanism.

3 It may, as in our experimental animals, profoundly damage the liver and spleen parenchyma, with early and late degenerative changes.

4 It is a radio active substance, and undoubtedly has dangerous cumulative radio active effects.

(1) ORR, M. Eine neue Methode zur röntgenologischen Darstellung der Milz (Lienographie). Fortschr a d Geb d Röntgenstrahlen, September, 1929, 40, 497-501.

(2) RADT, PAUL. Eine Methode zur röntgenologischen Kontrastdarstellung vom Milz und Leber. Klin Wchnschr, Nov 12, 1929, 8, 2128, 2129.

(3) Idem. Eine neue Methode zur röntgenologischen Sichtbarmachung von Leber und Milz durch Injektion eines Kontrastmittels (Hepato Lienographie). Med Klin, Dec 19, 1930, 26, 1888-1891.

(4) BAUMANN, H., and SCHILLING, C. Zur Kontrastuntersuchung von Milz und Leber. Klin Wchnschr, July 4, 1931, 10, 1249-1252.

(5) PAFENHOLZ, W., and SCHÜRMBYER, A. Änderungen der Milz- und Lebergrösse im Röntgenbild unter verschiedenen Kreislaufbedingungen. Klin Wchnschr, Nov 7, 1931, 10, 2076-2078.

(6) RANDEKATH, EDMUND. Anatomische Befunde nach intravenöser Thoriuminjektion (Präparat Thorotrast" Heyden 1073a) beim Menschen zum Zwecke der Hepatolienographie. Klin Wchnschr, Jan 23, 1932, 11, 144-146.

(7) TRIPOLI, C. J., and HAAM, E. Effects of Toxic and Non-toxic Doses of Thorium Dioxide in Various Animals. Proc Soc Exper Biol and Med, June, 1932, 29, 1053-1056.

(8) IRWIN, DUDLEY A. The Experimental Intravenous Administration of Colloidal Thorium Dioxide. Canad Med Assn Jour, August 1932, 27, 130-135.

(9) MACDONALD, IAN G. The Use of Thorium Dioxide as an Aid to Clinical Diagnosis. Canad Med Assn Jour, August, 1932, 27, 136, 137.

(10) DICKSON, W. H. Thorotrast, a New Contrast Medium for Radiological Diagnosis. Canad Med Assn Jour, August 1932, 27, 125-129.

(11) LEIPERT, THEODOR. Ueber die Verteilung des Thoriums im Organismus nach Injektion von Thorotrast. Wien klin Wchnschr, Sept 4 1931, 44, 1135, 1136.

(12) OTELL, L. S. The Reticulo-endothelial System and its Relation to the Roentgen Study of the Liver and Spleen after the Intravenous Administration of Thorium Dioxide Solution. RADIOLOGY, September, 1932, 19, 148-157.

(13) YATER, W. M., and OTELL, L. S. The Differential Diagnosis of Diseases of the Liver and Spleen by the Aid of Roentgenography after the Intravenous Injection of Thorotrast (Thorium Dioxide Sol). Am Jour Roentgenol and Rad Ther, February 1933, 29, 172-181.

(14) VEAL, J. R., and MCFETRIDGE, ELIZABETH M. Technical Considerations on Arteriography of the Extremities with Thorotrast. Am Jour Roentgenol and Rad Ther, July, 1934, 32, 64-71.

(15) HARRIS, WILLIAM H. Histo-pathological Effects of Thorium on Lymphatic Glands of Animals Visualized by the Menville Ane Method. Proc Soc Exper Biol and Med, June, 1932, 29, 1049-1051.

(16) STÖR, O. Untersuchungen über die Brauchbarkeit unserer Kontrastmittel zur Angiographie des gesunden und kranken Gefässes. Arch f klin Chir, June 1934, 179, 502-518.

(17) LERICHE, RENE. Sur la Benignité des artériographies au thorotrast. Bull et mem Soc nat de chir, Feb 16 1935, 61, 175-180.

(18) HARRIS, WILLIAM H., and FRIEDRICH, A. V. Microscopic Changes Produced in Tissues of Animals Injected with Thorium Dioxide for Spleno-hepatography. Proc Soc Exper Biol and Med, June, 1932, 29, 1047-1049.

(19) TRIPOLI, C. J., HAAM, E., and LEHMAN, BURTON. Roentgenographic Visualization of the Liver and

PERIPHERAL BLOOD PHENOMENA AND DIFFERENTIAL RESPONSE OF BONE MARROW AND LYMPH NODES TO HYPERPYREXIA¹

By CHARLES A. DOAN, M.D.,² *Columbus, Ohio*

Division of Research Medicine, Department of Medicine, Ohio State University

THE importance of the cellular elements of the blood and connective tissues to the maintenance of health and the control of disease has been increasingly apparent since the early studies of Metchnikoff. It is now recognized that every circumstance which affects the complex mammalian body affects the hemopoietic mechanism, in some degree, for 'weal or woe.' Most assuredly is this true of all physical or physico-chemical agents. Deep x-ray, the gamma rays of radium, mesothorium, thorium X, and other radio-active substances are now known, after a costly toll of scientific and industrial lives, to have a special destructive affinity for the hemopoietic tissues. Lymphatic tissues are perhaps the most susceptible, while myelopoiesis and erythrocytogenesis show a variable latent period before the destructive effect becomes apparent.

Personal observations at the Rockefeller Institute (1) with the introduction of radium chloride and mesothorium in small dosage in rabbits over a prolonged period (more than a year) resulted not only in the progressive destruction and inhibition of cytogenesis in lymph nodes and bone marrow, but in two instances osteogenic sarcomas developed terminally.

The question as to whether under favorable circumstances these physical agents may ever be primarily stimulatory has long been debated. "Stimulating" doses ($1/20$ SED, 39 r units) of x-ray have been advocated in agranulocytic angina, for example (2). It has been our experience (3, 4), however, that under

experimental conditions one single x-ray exposure, of even smaller dosage (19 r units) invariably produced definite nuclear chromatin degeneration in individual myelocytes throughout the femoral marrow in pigeons, as observed at the end of 24 hours.

Knowing these facts about the cells of the blood and their sites of origin, it becomes important to analyze and to appraise the effect of any new therapeutic procedure upon these important accessories to the total defense forces and strategy of the body in disease. Wherefore, the present study of the development, the distribution, and the functional efficiency of the cellular forces of the body as influenced by "fever," induced by the various means which have been advocated and are being used to-day in modern medical practice. Through the interest of Professor Dreese, and with the co-operation of Professor Byrne, of the Department of Electrical Engineering, Ohio State University, a high frequency, short wave radiotherm was constructed, installed in the Medical Research laboratories, and a comprehensive and extensive series of studies in rabbits was undertaken in 1932. In April, 1934, through the courtesy of Mr. Charles F. Kettering and Dr. Walter Simpson, an air-conditioned fever cabinet, the Kettering Hypertherm, was installed on the Research Service, the University Hospital, making it possible to extend our studies of the cellular reactions during artificially induced hyperpyrexia to selected human patients. Meantime, similar cellular studies have been made for comparison and contrast, during fever episodes induced by the intravenous inoculation of typhoid vaccine, and by malaria inocula. In several instances the same patients were sub-

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

² Dr. Malcolm M. Hargraves was associated in the fever studies and Miss Lucile Kester, R.N., was the nurse technician in charge of the Kettering Hypertherm cabinet.

(60) POPPER, H L, and KLEIN, E Über Hepatographie München med Wchnschr, Oct. 29, 1931, 78, 1829-1830

(61) MARTLAND, H S The Occurrence of Malignancy in Radioactive Persons Am Jour Cancer, October, 1931 15, 2435-2516

(62) STEWART, W H EINHORN M and ILICK, H E Hepatography and Lenography Following the Injection of Thorium Dioxide Sol (Thorotrast) Am Jour Roentgenol and Rad Ther, January, 1932, 27, 53-58

(63) BÜNGELER W and KRAUTWIG, J Ist die Hepatographie mit Thorotrast eine unschädliche diagnostische Methode? Klin Wchnschr, January, 1932, 11, 142-144

(64) BÜCHNER, FRANZ Zur Kontrastuntersuchung von Milz und Leber mit Thoriumdioxid Klin Wchnschr, June 18, 1932, 11, 1058-1060

(65) ANDERS, H E and LEITNER Z Ueber die röntgenologische Darstellung von Milz, Leber und Knochenmark durch Thoriumdioxid und ihre Histologischen Grundlagen Klin Wchnschr, June 25, 1932 '1, 1097-1100

(66) LEITNER Z Experimentelle Studien zur Darstellung innerer Organe mit Thorotrast Fortschr a d Geb d Röntgenstrahlen July 1932, 46, 47-52

(67) SHUTE EVAN and DAVIS M E Histologic Changes in Rabbits and in Dogs Following the Intravenous Injection of Thorium Preparations Arch Path January 1933, 15, 27-34

(68) COUNCIL ON PHARMACY and CHEMISTRY Thoro-

trast Jour Am Med Assn Dec 24, 1932 99, 2183-2185

(69) PEARSE, H E Jour Am Med Assn, Feb 23, 1935, 104, 618-623

(70) WARREN, S L Personal communication

(71) FLEMING, A J, and CHASE, W H The Effects of Administration of Thorium Dioxide Surg, Gynec and Obst, August, 1936, 63, 145-148

(72) TAFT R B Doctors Warned of Danger in Use of Diagnostic Aid Science News Letter Oct 10, 1936 30, 230

(73) Idem The Radio activity of Thorium Dioxide Sol A Preliminary Report Jour Am Med Assn, May 22, 1937, 108, 1779-1781

(74) SELBIE F R Experimental Production of Sarcoma with Thorotrast Lancet, Oct 10 1936, 2, 847, 848

(75) ROUSSY G OBERLING, C GUÉRIN M Production of Sarcoma in White Rats by Colloidal Thorium Dioxide Strahlentherapie 1936, 56, 160-167

(76) EVANS R D Millionth Gram of Radium Detected in Human Body Science News Letter, Dec 5, 1936

(77) Idem Personal communication

(78) DUVAL, P, REGAUD ROUHIER BAZI, L BECLERE, A Report of Commission Mem Acad de chir Nov 25, 1936 62, 1276, Abstract in Jour d'urol March 1937, 43, 241, 242

(79) MARTLAND, H S Occupational Poisoning in Manufacture of Luminous Watch Dials Jour Am Med Assn Feb 16 1929 p 552

postmortem surveys of the tissues after varying periods of hyperpyrexia, reveal the double mechanism of cell emigration into the tissues and cell destruction and regenerative inhibition as responsible for the leukopenia. In a series of nine rabbits febrile for varying periods from 50 minutes to 23 hours and autopsied immediately thereafter (see Table I), degenerating and fragmenting lymphocytes were found as a prominent feature in the lymph nodes of all. Even with the shorter periods of fever the evidence of lymphocyte destruction was immediate and striking. After longer periods of sustained fever a progressive hypoplasia of the lymphatic tissues developed, with marked infiltration of neutrophilic granulocytes, endothelial hyperplasia and desquamation, with the appearance of great numbers of phagocytic clasmatocytes. As observed in other series of animals in which survival permitted eventual cellular regeneration, lymphopoiesis did not become effective for some hours following the return of the temperatures to normal.

The bone marrow behaved rather dif-

ferently. The criteria of cell degeneration and disintegration were most prominent in the early minutes or hour of temperature elevation, to be followed promptly by evidence of regeneration with increased numbers of mitotic figures in the myeloid foci and increasing myelopoietic hyperplasia at the expense of the marrow fat cells, even without deferescence of the fever. An increased delivery of granulocytes to the circulation was apparent from the dilated sinuses and depleted myeloid reservoirs. This has been further demonstrated by differential counts of the myeloid-erythroid cell ratio in serial marrow samplings. After 23 hours of continuous fever at 108° to 109° F the myeloid hyperplasia, with only equivocal evidence of cell destruction and no increase in phagocytic clasmatocytes, was in sharp contrast to the findings in the lymph nodes and other tissues of the same animal.

It would seem, therefore, that the lymphopenia during fever in the rabbit reflects both a destruction of lymphocytes and an inhibition of lymphopoiesis, the

TABLE I—BONE MARROW AND LYMPH NODE REACTIONS TO VARYING PERIODS OF CONTINUOUS FEVER

Rabbit No	Biopsy Lymph Node and B M	Duration of Fever above 105° F	Method of Fever Induction	Lymph Nodes			Bone Marrow		
				Lymphocytes Degeneration and Fragmentation	Polymorphonuclear Infiltration	Clasmatocyte Reaction	Cell Degeneration and Fragmentation	Myeloid Hyperplasia with Mitosis	Clasmatocyte Reaction
458	No	50 min	R	+ to +++	=	=	++++	+	0
457	Yes	1 hr	R	+	0	+	0	=	0
446	Yes	1 1/2 hr	R	++++	+	=	0	++	0
448	Yes	2 1/4 hr	H	+++	0	++	+++	+	=
450	Yes	2 1/2 hr	H	++++	++	+++	0	++	0
438	Yes	3 hr	R	+++	++	+++	=	++	0
453	Yes	5 hr	R	++ (hypoplasia)	++++	+++	++	++	+
413	No	10 hr	R	+++ (hypoplasia)	+++	+++	++	++	0
469	No	24 hr	R	+ (hypoplasia) (no regeneration)	+++	++++	=	+++	0

- (60) POPPER, H L, and KLEIN, E Uber Hepatobenographie Munchen med Wchnschr, Oct 29, 1931, 78, 1829, 1830
- (61) MARTLAND, H S The Occurrence of Malignancy in Radioactive Persons Am Jour Cancer, October, 1931, 15, 2435-2516
- (62) STEWART, W H EINHORN, M and ILICK, H E Hepatography and Lienography Following the Injection of Thorium Dioxide Sol (Thorotrast) Am Jour Roentgenol and Rad Ther, January, 1932, 27, 53-58
- (63) BÜNGELER, W, and KRAUTWIG, J Ist die Hepatobenographie mit Thorotrast eine unschädliche diagnostische Methode? Klin Wchnschr, January 1932, 11, 142-144
- (64) BÜCHNER, FRANZ Zur Kontrastuntersuchung von Milz und Leber mit Thoriumdioxyd Klin Wchnschr, June 18, 1932 11, 1058-1060
- (65) ANDERS, H E and LEITNER, Z Ueber die röntgenologische Darstellung von Milz, Leber und Knochenmark durch Thoriumdioxyd und ihre Histologischen Grundlagen Klin Wchnschr, June 25 1932, 11, 1097-1100
- (66) LEITNER, Z Experimentelle Studien zur Darstellung innerer Organe mit Thorotrast Fortschr a d Geb d Röntgenstrahlen July, 1932, 46, 47-52
- (67) SHUTE EVAN and DAVIS, M E Histologic Changes in Rabbits and in Dogs Following the Intravenous Injection of Thorium Preparations Arch Path January 1933, 15, 27-34
- (68) COUNCIL ON PHARMACY and CHEMISTRY Thorotrast Jour Am Med Assn Dec 24, 1932, 99, 2183-2185
- (69) PEARSE H E Jour Am Med Assn, Feb 23 1935, 104, 618-623
- (70) WARREN, S L Personal communication
- (71) FLEMING, A J, and CHASE, W H The Effects of Administration of Thorium Dioxide Surg, Gynec and Obst, August 1936, 63, 145-148
- (72) TAFT, R B Doctors Warned of Danger in Use of Diagnostic Aid Science News Letter Oct 10, 1936 30, 230
- (73) Idem The Radio-activity of Thorium Dioxide Sol A Preliminary Report Jour Am Med Assn, May 22 1937, 108, 1779-1781
- (74) SELBIE, F R Experimental Production of Sarcoma with Thorotrast Lancet, Oct 10 1936, 2, 847 848
- (75) ROUSSA G OBERLING, C GUÉRIN M Production of Sarcoma in White Rats by Colloidal Thorium Dioxide Strahlentherapie 1936 56, 160-167
- (76) EVANS R D Millhouth Gram of Radium Detected in Human Body Science News Letter, Dec 5, 1936
- (77) Idem Personal communication
- (78) DUVAL P, REGAUD ROUHIER BAZI L BECLÈRE, A Report of Commission Mem Acad de chir, Nov 25 1936 62, 1276 Abstract in Jour d'urol March 1937, 43, 241, 242
- (79) MARTLAND, H S Occupational Poisoning in Manufacture of Luminous Watch Dials Jour Am Med Assn, Feb 16 1929 p 552

been repeatedly proved. The total number of lobes noted while counting 100 neutrophilic leukocytes should then reflect the relative degree of average maturity at which the cells at any given time are circulating in the blood. Theoretically, the greatest possible "shift to the left" would be indicated by 100 lobes, each cell then being a "band form" or myelocyte, conversely, if all granulocytes had five distinct lobes the total for 100 cells would be 500, an extreme degree of "right shift" for the bone marrow. Taking this index before fevering each time as a base line, it has been found that there is a "shift to the left" as expressed by a fall in the Lobe Index curve as leukocytosis progresses. This is indicative of an increased bone marrow delivery of granulocytes and not simply the release of cells from reserve depots. As the leukocytosis declines there is a gradual shift to the right to the pre-fevering index.

The lymphocytes early are depressed to a very low level (200 to 500 cells) as the fever rises. There is rarely an initial lymphocytosis, made up of mature and older lymphocytes, which usually rapidly disappear from the blood. Occasionally during fevering there are small wave-like reappearances of lymphocytes which again promptly subside, these lymphocytes are uniformly young cells. The main lymphocytic response comes from 10 to 18 hours after the height of the fever. This is the last cell type to increase in the peripheral blood. These returning cells are invariably young, many lymphoblasts being scattered among young, deeply basophilic lymphocytes. We believe that all indications so far point to a destruction of lymphocytic elements during hyperpyrexia, with a regeneration and delivery of new lymphocytes to the peripheral blood in the post-febrile period.

There is also a depression of the monocyte count in the human subject during the early stages of fever, with a secondary monocytosis following about 9 to 12 hours later. These cells make their reappearance usually with the decline of the granulocy-

tosis, although there are occasional tide-like deliveries when the leukocytosis is at its peak. The monocytes found after fever are very definitely younger cells than those in the circulation before fever and they make their appearance in periodic showers. No increase in phagocytic activity was noted in these cells.

Having established a febrile hemogram with the foregoing characteristics, an attempt was made to study the effect of duration and height of temperature on this cellular reaction. When an individual who had a typical hemogram following five hours of fever at 106° was subjected to five hours of fever not surpassing 101.4° , but with definite vasodilation and sweating, the hemogram showed only the fluctuation which one would expect from ordinary temporal variations. Another individual, who had had a typical hemogram with a five-hour fevering, when given ten continuous hours of the same type of fevering showed only a questionable prolongation of the period of leukocytosis. The same individual subjected to a rapid rise in temperature up to 108° F, but not sustained, gave a cellular response almost identical in degree and duration with that observed following five hours at 105° F. Repetition of these variations in another individual gave similar results.

In order to determine whether this increase in circulating cells might be related to splenic contraction, to cyanosis, to excitement, or to a combination of these factors, certain pertinent observations were made. One individual, who previously with fever had given a leukocytosis between 40,000 and 60,000, was subjected to an "adrenalin test." Peripheral blood counts were taken every 15 minutes for one hour before the administration of 1 c.c. of 1:1,000 solution of adrenalin intramuscularly. Successive short interval counts thereafter during the period of induced splenic contraction showed little change in the blood picture other than a moderate increase in lymphocytes. There was nothing comparable to the fluctuation shown

tive differential counts were made from these preparations

RADIOTHERM AND HYPERTHERM

Experimental Observations—The hemo-gram which accompanies and follows the febrile state was first established in the radiotherm, and later confirmed in the Kettering hypertherm, using normal adult rabbits as subjects. No essential difference in the cellular responses has been noted in comparing these two methods of fever induction.

During the period of maintained hyperpyrexia (108° to 109.8° F) a definite and usually marked leukopenia develops. The circulating lymphocytic elements are invariably reduced, the granulocytes, in the majority of instances, also participating in the general reduction in total white cells. This diminution of white cells in the blood stream continues as long as the fever is maintained—up to 23 hours in one experiment in this series. Qualitatively, the granulocytes may “shift to the right” with increased nuclear lobes at the onset of fever and neutropenia. Later a marked decrease in the “lobe index” or Arneth-Schilling “left shift” reflects the marrow delivery of less mature elements. If the period of fever is limited to a few hours and the temperature has been kept within sublethal limits, the regenerative potentialities of the bone marrow in the individual animal under observation is measured by the height of the leukocytosis which is attained during the succeeding 24 hours. The neutrophilic granulocytes respond first, rising reciprocally as the temperature falls, the lymphocytes returning to the circulation only considerably later. As with the neutrophils, so do the lymphocytes reflect the regenerative activity at their sites of formation as they reappear in the circulation—with basophilic cytoplasm, abundant mitochondria and vesicular nuclei, significant of a post-febrile hyperplasia of the germinal centers in the lymph nodes.

Comparative studies of lymph nodes and bone marrow, taken at biopsy, with

marked than that seen in the hyperthermia-induced monocytosis. The fluctuations and qualitative changes in the lymphocytes are not unlike those observed following the delayed hyperthermia lymphocytosis.

Studies were made of this type of fever induction to determine the effect on the hemogram of variations in temperature range and the number of organisms injected and there seemed to be no correlation of either. A temperature of 100.4° induced by fifty million organisms was accompanied by as high a total white count as followed a temperature of 105° with fifty million organisms. The persistence of the leukocytosis with the higher temperature was a little longer than that with the lower temperature, as it was in the hyperthermia experiment.

FEVER INDUCED BY MALARIA INOCULATA

The hemogram produced by malaria is distinctive. The most noticeable thing is a fall in total white count during the incubation period to give a patient, who, before inoculation, had carried a high normal count, a very marked leukopenia. The polymorphonuclear leukocytes are markedly shifted to the left with the majority of cells being one-lobed, while occasional metamyelocytes and myelocytes C are encountered. The leukocytosis induced by the hyperpyrexia following a chill is comparatively small, seldom going over 14,000 or 15,000 in a patient who had previously given and who subsequently gave a leukocytosis of 40,000 to 60,000 with the hyperthermia. The lymphocytes follow the same general trend as in other febrile hemograms with the exception that lymphoblasts are more numerous and extremely young lymphocytes dominate in the secondary lymphocytosis which follows the fever period. The monocytes are most strikingly altered in their qualitative characteristics. They return to the circulation to make at times 30 to 40 per cent of the total count and are extremely young and markedly stimulated. The entire age range for this cell type can be seen, from monoblasts to mature monocytes, and the cells vary in size markedly,

the majority being much larger than those normally seen in the peripheral blood. The vacuolization is not that of the rosette formation as seen in the epithelioid type of monocyte, but is rather a diffuse scattering of enlarging vacuoles throughout the increased quantity of cytoplasm. There is a marked diminution of lymphocytes and monocytes during the chill with resultant leukopenia. During the period of monocytosis there also appears in the peripheral blood an abnormal number of actively phagocytic clasmatoocytes. They have been seen in same counts as high as 7 and 8 per cent, and this has been observed in no febrile hemogram induced by agents other than malaria.

HUMAN BONE MARROW BIOPSY STUDIES

Serial sternal bone marrow biopsies were done on one patient who was subjected to hyperthermia fevering first, and, then, after an adequate rest period, was inoculated with malaria. The first biopsy was done before any therapy and during a period of observation. It showed a normal bone marrow picture by actual differential count of cells in supravital preparations. The second biopsy was done over a month later at the completion of the patient's third hyperthermia treatment, just after removal from the cabinet. The differential marrow count at this time was practically identical with that of the first. The third biopsy was done after the completion of eight malarial paroxysms, and there was a striking difference in the marrow picture. A marked "shift to the left" in the myeloid elements was shown by a significant increase in the myelocytes B and myelocytes A at the expense of the normally dominant myelocytes C. There was also a "shift to the left" in the erythroid elements. The appearance of plasma cells and a marked increase in highly phagocytic clasmatoocytes was outstanding.

CONCLUSIONS

In conclusion, we may say that there is a rather constant hemopoietic response to "fever" and that the majority of the cells

jected to all three methods of fever induction, a suitable interval having intervened between each (5)

TECHNICS EMPLOYED

Previous studies of the white blood cells have demonstrated the frequent physiologic fluctuations which occur, and which reflect at times redistribution, and at times bone marrow and lymph node delivery phenomena, in the peripheral circulation. The sensitive lability of the leukocyte response in disease, and to any physiological or chemical disturbance, has been repeatedly demonstrated in recent years. Any study, therefore, of the influence of induced hyperpyrexia upon the cellular equilibria of the blood must presuppose an adequate base line of frequently repeated successive observations (every 15 to 20 minutes), such counts being continued throughout the actual fever episode, and as long as any significant qualitative as well as quantitative alterations in the cells remain—sometimes a 24- to 36-hour period.

The technics employed were standardized throughout. The marginal ear veins were used for the collection of blood samples in the rabbits. Capillary blood from a uniformly deep automatic lancet puncture of the finger furnished the samples each time from patients, except during the actual cabinet period, when the ear was used. These sources have been proved to reflect with equal sensitivity any significant changes in the cellular concentration of the peripheral blood. After discarding the first drop of blood, supravital and fixed cover slip blood films, total white count, total red count, and hemoglobin were always taken in the order named. Intravenous blood samples were taken at less frequent intervals for sedimentation, cell volume, and plasma volume (dye method) determinations. The Wright-Giemsa staining technic was applied to the fixed blood films for permanent record, and all Arneith-Schilling neutrophil and Wiseman lymphocyte qualita-

THE ROENTGEN VISUALIZATION OF CRANIAL NERVES AFTER INTRACISTERNAL INJECTION OF THOROTRAST

By J Q GRIFFITH, JR, M D,¹ P J HODES, M D, and W A JEFFERS, M D,
Philadelphia

From the Robinette Foundation, the Medical Clinic, the Department of Radiology, and the Pepper Laboratory of the Hospital of the University of Pennsylvania

THE present communication will describe a method for decalcifying bones of the skull which has made roentgen visualization of the intracranial structures possible. We believe the method may be of value in the study of certain experimental problems in animals, as it has allowed us to demonstrate thorotrast within perineural sheathes of certain cranial nerves. Thirty albino rats and eight cats were used for these experiments.

Previous studies concerning hypertension following intracisternal kaolin injection in rats have suggested that kaolin blocks perineural channels. During the course of these experiments, we (J Q G and W A J) repeatedly noticed that thorotrast injected intracisternally appeared in the cervical lymph nodes in normal rats soon after infection, whereas those rats in which kaolin had been injected previously failed to demonstrate similar perineural extension. While these experiments suggested that kaolin blocked perineural channels, roentgen evidence of this intracranial block could not be obtained due to the density of the bones of the skull, which made visualization of delicate thorotrast-filled structures impossible.

METHOD

(A) *Rats*—Under ether anesthesia, cisternal puncture was performed and approximately 0.04 c c of cerebrospinal fluid withdrawn and a corresponding amount of thorotrast injected. Animals were decapitated under ether anesthesia at intervals varying from five minutes to 48 hours after injection. After removing the mandible and soft tissues, the heads

were decalcified by submerging them in 100 c c of 3 per cent hydrochloric acid, changing the acid twice daily. Decalcification was usually complete in three days, following which roentgenograms were taken.

(B) *Cats*—The procedure was similar except (1) 0.5 c c of spinal fluid was withdrawn and 0.5 c c of thorotrast injected into the cisterna, (2) decalcification required from two to three weeks in approximately a pint of the dilute hydrochloric acid.

RESULTS

As the cat is larger than the rat, we chose roentgenograms of cats for more convenient illustration.

Under normal conditions, the skull bones conceal thorotrast-containing structures within the calvarium. Following decalcification, the physical features of the skull may be identified but the soft parts can not be differentiated roentgenographically (Fig 1). Thorotrast, injected during life, is immediately disseminated over the brain, allowing visualization of the convolitional markings (Fig 2). Animals allowed to live about thirty minutes before decapitation show roentgen evidence (Fig 3) of thorotrast along certain cranial nerves. (This has been confirmed microscopically by identifying thorotrast within the perineural spaces.)

Olfactory nerves, commonly seen roentgenographically in rats, are rarely demonstrated in cats. The optic nerves are visualized in both animals (Fig 4). These nerves, when viewed stereoscopically, may be followed throughout their course from the chiasm to the optic disks, where they end abruptly. They are not so well visualized in animals allowed to live over one

¹ Heckscher Fellow in Medicine

granulopenia initially may represent some destructive effect of the rising temperature upon myeloid cells, but soon the marrow adjusts and increases its output with a corresponding relative increase in circulating young forms. During the continuation of fever, however, this marrow activity has never been observed to result in a leukocytosis, because of the rapid exodus of the cells from the blood stream into the tissues. If and when the high temperatures begin to subside, the granulocytes rapidly increase in the circulating blood, reaching a high point during the succeeding 24 hours, and showing a return to a more right-sided shift as the equilibria become re-established.

The monocytes in the normal rabbit seem to participate in only a minor degree in the uncomplicated reaction to simple fever. If, however, fever be administered to a tuberculous rabbit, a very different hemogram is observed, the increased monocyte-epithelioid content of the tuberculous tissues being reflected by a high monocyte rise in the blood, with more rapid dissemination of the disease and toxic symptoms and hemorrhage in excess of the control animals (6).

Insofar as the cellular equilibria in rabbits are concerned, therefore, fever *per se* destroys and inhibits lymphocytic elements in direct proportion to the height and duration of the temperature. A marked infiltration of polymorphonuclear leukocytes occurs in the lymph nodes and a great increase is noted in highly phagocytic clasmatocytes, granulopoiesis, on the other hand, is stimulated, but qualitative changes in the circulating cells and a study of the bone marrow for generative activity and the general connective tissues for leukocytic infiltration provide the evidence, rather than a peripheral leukocytosis. In any pathologic condition therefore in which a reduction in lymphocytic accumulations in the tissues is desirable, and in which the phagocytic activity of clasmatocytes and the defense potentialities of neutrophilic granulocytes are theoretically desirable, the judicious

use of fever might be considered a rational procedure.

HYPERTHERM STUDIES IN SELECTED HUMAN PATIENTS

In the human subject the preliminary leukopenia just described, is often absent, with the leukocytosis starting from the pre-febrile level in from three to seven hours after the induction of fever. The degree of leukocytosis varies from individual to individual and in the same patient from treatment to treatment. The total white count has varied in our experience from 10,000 to 60,000. The initial cellular response is made up primarily of neutrophilic polymorphonuclear leukocytes. The most striking thing about this early phase of the reaction is the irregularity in the curve of total white cells. The increase in cells does not progress smoothly and steadily upward, but rather by irregular fluctuations, producing marked peaks and depressions which at times reflect as much as a 30,000 difference in cell level in a 20-minute period. By such tide-like variations, the peak of leukocytosis is finally reached. Occasionally there are two or three such peaks divided by intervening low points. The curve of the total white blood count gradually declines in the same manner as it ascended, with not infrequently a less marked secondary leukocyte peak which follows some hours after the original maximum point. Inasmuch as this is largely a neutrophilic response, Arneth-Schilling counts were carefully made to analyze the findings and interpret the results. In going over the data it seemed important to attempt to recognize small changes in the bone marrow delivery of granulocytes, that the mechanism of response might be more accurately appraised. The usual Arneth-Schilling indices seemed at times less sensitive than desired, so that a method of expression for the "left shift" was devised, which might be termed the "Lobe Index." That the number of lobes in an individual granulocyte may be interpreted in terms of the relative age of the cell has

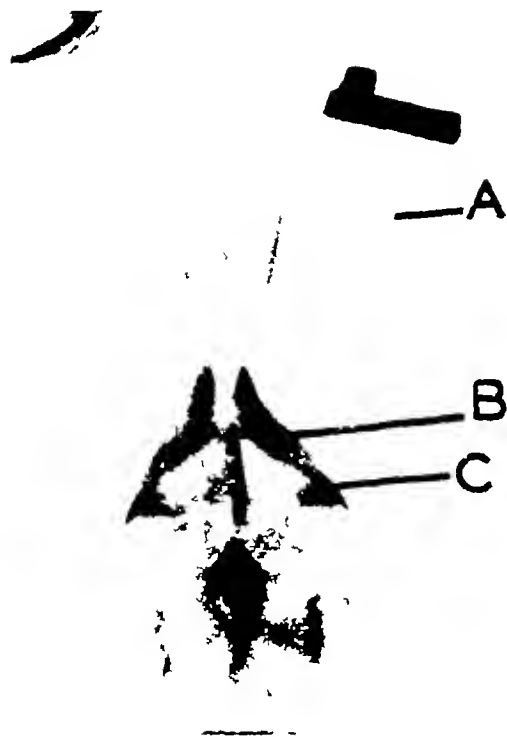


Fig. 5 Rat kaolin previously injected to produce hypertension. Note ventricular detail (A) Eye (B) Lateral ventricle (C) Posterior portion of lateral ventricle

hour, although the disk region may retain its opacity for 48 hours after injection. Other cranial nerves, although less distinct, have also been demonstrated. In rats, one can occasionally recognize the shadows of the trunks of the fifth and

eighth nerves with ease. The shadows of the third, fourth, and sixth nerves and the ophthalmic division of the fifth nerve are not easily identified because they lie in a group close to one another. This is also true of the tenth, eleventh, and twelfth nerves which form a separate group. None of these nerves with the exception of the optic and perhaps the olfactory nerves, can be demonstrated in cats.

The roentgen findings were distinctly different in animals made hypertensive with kaolin in that these animals failed to show evidence of perineural extension and cranial nerve visualization (Fig. 5).

SUMMARY

1 Attempts to demonstrate intracranial structures in undecalcified skulls have been unsuccessful.

2 Thorotrast injected into the cisterna magna in rats and cats may be demonstrated in the sheathes of certain cranial nerves roentgenographically in decalcified skulls.

3 Thorotrast does not pass to the sheathes of the cranial nerves following a previous intracisternal injection of kaolin.

BIBLIOGRAPHY

- (1) GRIFFITH J. Q. JR., JEFFERS W. A. and LINDAUER M. A. *Am Jour Physiol*, October 1935 113, 285.

in the febrile hemogram from this same patient. To further check the splenic influence on this hemogram, an individual who had previously (February, 1934) been splenectomized, was given four hours of fever between 106° and 107° F. A leukocytosis of 50,000 was reached by the same tide-like variations as in normal individuals. The only marked difference noted was the longer period during which the leukocytosis was sustained, returning slowly toward the pre-febrile base line over a 36-hour period.

Inasmuch as cyanosis is recognized as a stimulus to the spleen and bone marrow, its unexpected development in an individual whose hemogram had previously been determined during the usual course of fever provided the basis for a comparative hematologic study. This individual while taking his sixth hyperthermic treatment, became markedly excited during the induction stage, the incident culminating in a typical epileptiform seizure and the development of a very marked cyanosis. Upon removal from the cabinet, and following the intravenous administration of stimulants, the patient promptly recovered and seemingly returned to his pre-febrile state of rationality. During the time out of the cabinet his temperature fell to normal. Thinking it was safe to continue his treatment, he was again placed in the cabinet, and his systemic temperature was carried upward through the excitement stage. At this point he again developed marked restlessness and his convulsion recurred with the reappearance of the same intensity of cyanosis. He was immediately removed from the cabinet and no more fever therapy has been attempted in this patient. During these episodes just cited, blood counts were taken every 15 to 20 minutes, and no significant effect was noted which could be attributed either to the cyanosis, to excitement, or to the convulsions in his curve of leukocytosis. The patient did, however, develop a leukocytosis in proportion to the amount of fever which he had carried.

FEVER INDUCED BY INTRAVENOUS TYPHOID VACCINE

The febrile hemogram resulting from intravenous typhoid vaccine injections is similar to that observed with the hypertherm. In this study killed *Bacillus typhosus* organisms suspended in normal saline were used for the induction of the chill and fever, the same routine of blood cell counting being followed as in the hypertherm studies. The most noteworthy variation is the marked leukopenia which develops with the onset of the chill and which persists throughout its duration. There is marked peripheral vaso-constriction combined with muscular activity which occurs during the chill, and it is interesting to compare the effect of this peripheral cyanosis with the generalized cyanosis in the patient with convulsions mentioned above. Here a marked leukopenia was reflected in the granulocytes and monocytes, in the other instance there was no appreciable change in the blood cell equilibria. The peripheral vaso-constriction is probably an important factor in the production of this phenomenon. The granulocytes uniformly fall to a very low level, with a total count of between 2,500 and 4,000, while the monocytes completely disappear from the circulation and remain persistently absent for from three to eight hours. The neutrophils, however, rapidly return to the peripheral circulation with the passing of the chill and climb to a leukocytic peak which is in all respects comparable to other febrile hemograms. When these neutrophils are studied with the Arneith-differential using the Lobe Index, we find that there is a moderate shift to the left which, as time goes on, becomes more and more apparent. The shift to the left in this hemogram is far more pronounced than that seen in the hypertherm-induced reaction and with each new influx of cells there is a corresponding drop in the Lobe Index. The monocytes upon return to the circulation are young and moderately stimulated, and the stimulation of these cells, as shown by the formation of neutral red-stained vacuoles in their cytoplasm, is more

Sam W Donaldson, M D, 326 North Ingalls St, Ann Arbor, *Secretary-Treasurer*, E R Witwer, M D, Harper Hospital Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg

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king up the post-febrile leukocytosis of polymorphonuclear neutrophils newly derived by the bone marrow as shown by their youth. This part of the reaction may be non-specific and is by no means necessarily the most important from the standpoint of the fundamental body defenses. There is a destruction of lymphocytes during hyperpyrexia, as attested by the lymph node studies cited and by the return to the circulation, after a prolonged lymphopenia of very young cells. There is probably in the human patient some destruction or redistribution of monocytes as shown by a delayed monocytosis made up primarily of younger forms. The hemograms following malaria and *B typhosus* infections differ from those observed during fever induced by physical methods in the marked leukopenia during the chill, in the temporary disappearance of the monocyte from the circulation following typhoid, and in the marked stimulation of the monocyte in malaria and its moderate stimulation following typhoid vaccine. The shift to the left in the neutrophilic granulocytes in malaria is outstanding and the appearance of clasmatoocytes in the peripheral blood has been observed with no other type of fever study.

It has been suggested by Breutsch that the profound stimulation of phagocytic clasmatoocytes observed in malaria, as the result of red cell destruction by the plasmodia, provides an important cellular defensive weapon in the treatment of central nervous system syphilis, which is not available when other fevering methods are employed. Cunningham has emphasized the importance of clasmatoocytes in the control of experimental syphilis in rabbits. While it is true that the sternal marrow biopsy

studies in the human patients cited, and the rabbit bone marrows studied postmortem following hypertherm fever therapy did not show an increase in clasmatoocytes, we would call attention to the tremendous increase in these phagocytic cells elsewhere in the tissues, more especially in lymph nodes, spleen, and liver. To that extent, at least, artificial hyperthermia by physical means not only provides the thermal factor of importance for the inactivation of the treponema pallidum and the gonococcus, but has now been demonstrated to exert a profound effect upon the cellular equilibria of the body—in the directions which we believe, at the present time, to be the most effective in the mobilization of the defense forces of the body against these diseases. In short, hyperpyrexia acts as a two-edged sword cutting both ways in its rôle as "assistant extraordinary" to the humoral defense mechanisms of the body.

BIBLIOGRAPHY

- (1) SABIN F R, DOAN C A and FORKNER, C E. The Production of Osteogenic Sarcomata and the Effects on Lymph Nodes and Bone Marrow of Intravenous Injections of Radium Chloride and Mesothorium in Rabbits. *Jour Exper Med* August 1932, 56, 267-289.
- (2) FRIEDEMANN U, and ELKELES, A. Roentgen Therapy of Agranulocytosis. *Deutsche med Wchnschr*, June 6 1930 56, 947-950.
- TAUSSIG A E, and SCHNOEBELE, P C. Roentgen Therapy of Agranulocytosis. *Jour Am Med Assn* Dec 12 1931, 97, 1757-1761.
- (3) LEE, L A and DOAN, C A. The Effect of Small Doses of X ray and Radium on Myelopoiesis in Pigeon and Rabbit. *Arch Path (abstract)*, 1934, 18, 591.
- (4) DOAN, CHARLES A. Clinical Implications of Modern Physiologic Hematology. *Beaumont Lectures*, Bruce Pub Co. St Paul Minn., 1936.
- (5) HARGRAVES M M and DOAN, C A. The Physiologic Response of the Hemopoietic Tissues to Artificially Induced Fever. *Proc Fifth Annual Fever Conference* Dayton, 1935 pp 51-62.
- (6) DOAN C A and BIERBAUM OLGA. Studies with Artificial Liver in Experimental Tuberculosis. *Ohio Jour of Sci* 1936, 36, 117.

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LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE TEACHING OF RADIOLOGY IN SHORT COURSES

Medical science, ever-changing as it is, demands continuous education of its practitioners. The maintenance of a high standard of medical practice necessitates frequent visits to centers of learning by the average physician. The recognition of this fact in certain foreign countries has led to a system of post-graduate courses, which the physician, in characteristic fashion, is compelled to attend at stated intervals. In this country, adhering to our traditional and cherished attitude of *laissez-faire*, increasing opportunity for post graduate education is being afforded without compulsion. Sponsored by the organized profession, the state, or the university, a large number of short courses on various subjects, ranging in length from a few days to several months, are being offered, particularly to the general practitioner. Some of these are of the "refresher" variety, others are devoted to newer advances. It should be clearly understood that this discussion does not concern itself with the longer, more formal courses of graduate training in the specialties.

Radiology, dynamic subject that it is, inevitably must occupy an important position in the post-graduate education of the general practitioner but the question of just what should be taught this same practitioner as to the use of the roentgen rays has never been adequately answered. Some reasonably consistent attitude must shortly be adopted in order to guide those who are being called upon, more and more frequently, to teach radiological subjects in short courses.

On this matter two opinions prevail. One contemplates the teaching of the indications for roentgen diagnosis and therapy with its possibilities and limitations, but would avoid the technics of roentgenology. In this program the practical methods of application of the roentgen rays, specifically such matters as the details of dosage or the description of roentgen diagnostic signs, would not be presented. The other program is more inclusive

and, with due regard to the limitations imposed by the lack of preparation of the student and the short period of time in which the subject must be covered, envisages an attempt to teach both phases of radiological knowledge.

No one will cavil at the presentation of the possibilities and limitations of radiology in refresher courses for general practitioners. It is hardly possible to disseminate too much knowledge of this subject among all physicians. But no such unanimity of opinion prevails as to the desirability of teaching the specific details of roentgenologic procedure in this fashion. The fear of turning out half-baked specialists, of encouraging the incompetent and dangerously unskilled application of such a potent weapon as the roentgen rays, has permeated all radiological teaching and especially that concerned with short courses. Such misgivings, doubtless, are not without foundation, yet they should be reconsidered. The time has come to face this problem squarely and to ask ourselves: Can too much medical education really be harmful? Is it not true that the more a rational individual learns of a subject, the more he appreciates his own limitations?

Extensive experience with post-graduate teaching indicates that the majority of physicians who register for courses in radiology are already practicing roentgen diagnosis to some degree. In general they are the most progressive and conscientious practitioners in their community, but their situation in rural districts, where specialists in roentgenology are not available, makes this practice imperative. Any teaching which will improve the technic and diagnostic ability of these physicians is all to the good. That some practitioners who are not already "operating" an x-ray machine and have no real necessity for engaging in roentgen diagnosis may be induced to do so by the small knowledge gained in a short course is a possibility. It is more probable, however, that the imprudent

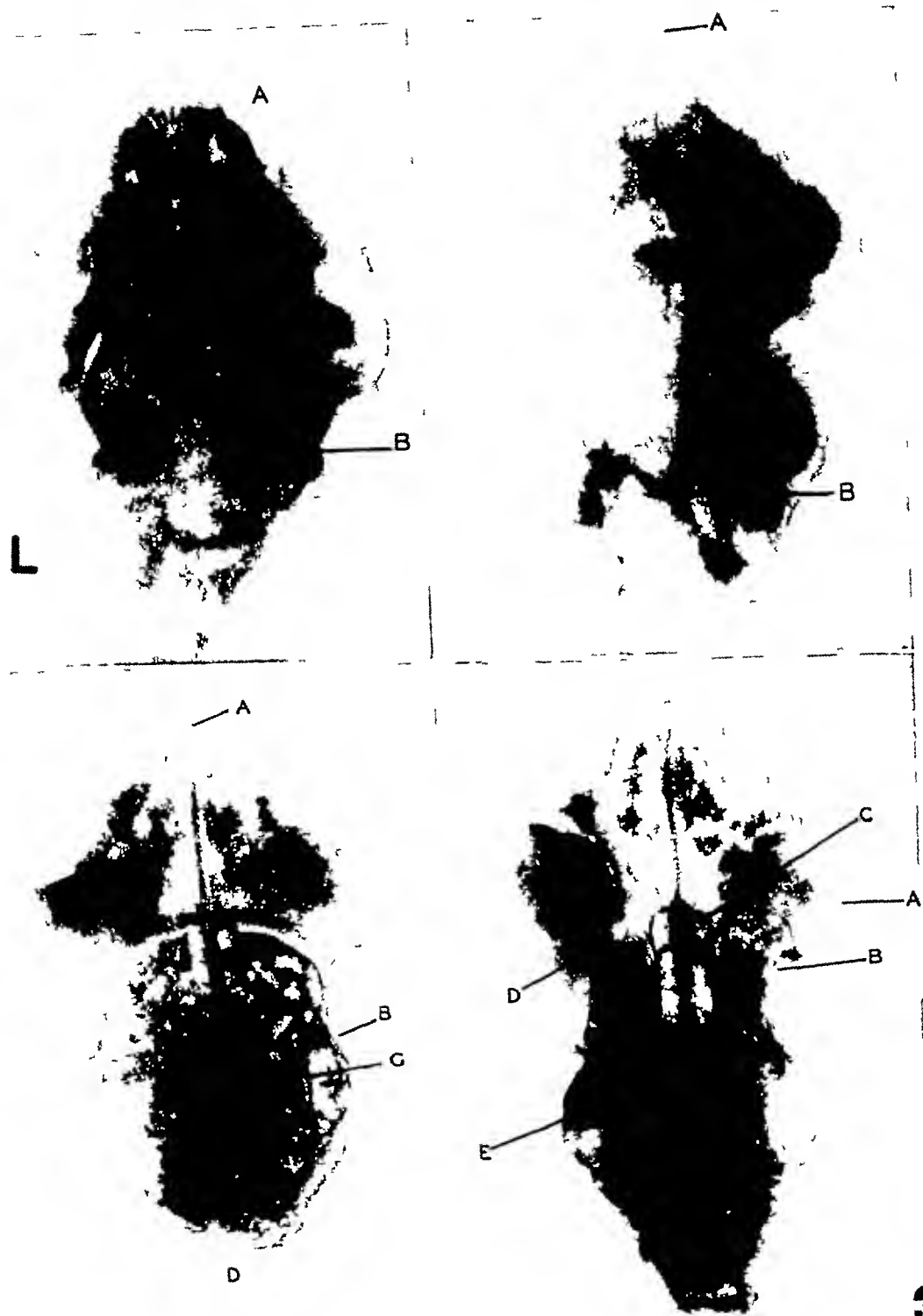


Fig. 1 (upper left) Cat normal appearance of skull (A) Nose (B) Occiput
 Fig. 2 (upper right) Decalcified skull of cat illustrated in Figure 1 (A) Nose (B) Occiput
 Fig. 3 (lower left) Cat thorotrast injected and cat sacrificed soon after skull decalcified (A) Nose (B) Subdural air (C) Thorotrast in subarachnoid space
 Fig. 4 (lower right) Cat thorotrast injected and cat sacrificed one hour after injection (A) Eye (B) Optic nerve (C) Olfactory nerves (D) Optic disc (E) Convolutional markings

subject The student is expected to read those articles which will supplement and add to his knowledge and it is hoped that the references quoted will be read more than the outline itself

The Outline contains 51 subjects which in a general way can be summarized as relating to the following topics Diseases of Bones and Joints, Brain, Mastoids, Sinuses, Teeth, Larynx, Chest and Heart, Gastro-intestinal Tract, Gall Bladder, Pyelography, Localization of Foreign Bodies, Physics of Radiation and Radium Therapy, Biological Effects of Irradiation, Typical Therapy Technics, Factors to be Considered in the Treatment of Tumors, Records for Radiation Therapy, Metastasis, and a detailed bibliography relating to the therapy of certain specific conditions

The general scheme of the Outline is most excellent and, as far as possible, the various subjects are discussed in the following order Definition, cause, gross morbid anatomy and physiology, roentgen-ray appearance, differential diagnosis, and treatment Subjects which do not lend themselves to such a consideration are outlined in an equally efficient manner

The Pennsylvania Radiological Society are to be complimented for sponsoring this practical and concise outline of study which should be very helpful to students of radiology and to those who are interested in a refresher course concerning the subject

LEHRBUCH DER RÖNTGENOLOGISCHEN DIFFERENTIALDIAGNOSTIK DER ERKRANKUNGEN DER BAUCHORGANE (Textbook of Roentgenologic Differential Diagnosis of Diseases of the Abdominal Organs) By Dr Med Habil WERNER TESCHENDORF, Chefartz des Strahleninstituts der Allgemeinen Ortskrankenkasse Köln A textbook of 477 pages containing 929 illustrations Published by Georg Thieme, Leipzig, 1937 Price 33 RM (in the U S) bound

This unique textbook by an outstanding German radiologist should be very popular with those physicians fortunate enough to read the German language The author has discussed in a very comprehensive and informative manner all the details entering into the roentgenographic differential diagnosis of abdominal disease The marginal notes in small type which connote the subject discussed in the contiguous text are a very useful innovation and facilitate a rapid perusal of the contents when

The volume consists of eight chapters which are captioned as follows Chapter 1, The Stomach, Chapter 2, The Operated Stomach, Chapter 3, The Duodenum, Chapter 4, The Biliary Tract, Chapter 5, The Small Intestine, Chapter 6, The Large Intestine Chapter 7, Kidney, Ureters, Bladder, and Prostate, Chapter 8, Artificial Pneumoperitoneum as Concerns the Liver, Pancreas, Spleen, and Abdominal Tumors

The chapters concerning the gastro-intestinal tract, particularly those relating to the stomach and duodenum, are unusually well presented Throughout the text frequent reference is made to the literature, both foreign and American, and as a rule the significant references have been included The consideration of cholecystography (16 pages) seems somewhat brief considering the importance of the subject, however, the pertinent facts have been covered in a very practical manner The subjects of terminal ileitis and related conditions are touched on rather briefly and American readers will feel that this consideration of the subject is inadequate

The author, who is personally interested in the technic of artificial pneumoperitoneum, presents some excellent illustrations portraying the value of this method of examination The interest of American radiologists in this procedure has lagged in recent years but, considering the excellent results achieved by the author with this type of examination, a reconsideration of its usefulness in certain abdominal conditions would seem justified

The general excellence of the illustrations is deserving of special commendation and these, together with the general typography, are a tribute to the publisher whose reputation for quality work is well known

RÖNTGENDIAGNOSTIK DER KNOCHEN- UND GELLENKRANKHEITEN (Roentgen Diagnosis of Diseases of Bones and Joints) by Professor Dr ROBERT KIENBÖCK, Vienna Volume I, Differential Diagnosis of Neoplastic Diseases of Bone. A volume of 104 pages, with 26 figures Published by Urban & Schwarzenberg, Berlin and Vienna, 1933 Price RM 8 50

In this book Professor Kienböck, one of the greatest European radiologists, discusses tumorous diseases of bone, a subject in which he is recognized as an international authority The various lesions are taken up in detail and con-

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section

CALIFORNIA

California Medical Association, Section on Radiology—Chairman, John D. Lawson, M.D., 1306 California State Bldg., Sacramento, Secretary, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

Los Angeles County Medical Association, Radiological Section—President, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena, Vice-president, E. N. Liljedahl, M.D., 1241 Shatto St., Secretary, Merl L. Pindell, M.D., 678 South Ferris Ave., Treasurer, Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club—Chairman, Raymond G. Taylor, M.D., 1212 Shatto St., Los Angeles, Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco.

San Francisco Radiological Society—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M. alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club—President, John S. Bouslog, M.D., 240 Metropolitan Bldg. Vice president, Sanford Withers, M.D., 304 Republic Bldg., Secretary, Ernst A. Schmidt, M.D., Colorado General Hospital, Treasurer, H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology—Chairman, Kenneth K. Kinney, M.D., 29 North Street, Willimantic. Vice chairman, Francis M. Dunn, M.D., 100 State Street, New London, Secretary-Treasurer, Max Chman, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida State Radiological Society—President, Gerald Raap, M.D., 165 S.E. First St., Miami. Vice president, H. O. Brown, M.D., 404 First Nat'l Bank Bldg., Tampa, Secretary-Treasurer, H. B. McEuen, M.D., 128 W. Adams St., Jacksonville.

GEORGIA

Georgia Radiological Society—President, James J. Clark, M.D., Doctors Bldg., Atlanta, Vice-president, William F. Lake, M.D., Medical Arts Bldg., Atlanta, Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society—President, David S. Beilin, M.D., 411 Garfield Ave., Vice president, Chester J. Challenger, M.D., 3117 Logan Blvd., Secretary-Treasurer, Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiological Society—President, Ivan Brouse, M.D., 316 W. State, Jacksonville, Vice president, Cesar Gianturco, M.D., Carle Hospital Clinic, Urbana, Secretary-Treasurer, Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section of Radiology—President, Roswell T. Pettit, M.D., 728 Columbus St., Ottawa, Secretary, Ralph G. Willy, M.D., 1138 N. Leavitt St., Chicago.

INDIANA

Indiana Roentgen Society—President, J. N. Collins, M.D., 23 E. Ohio St., Indianapolis. President elect, Stanley Clark, M.D., 108 N. Main St., South Bend, Vice president, Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne, Secretary-Treasurer, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section—Chairman, Marcus Ostro, M.D., 1810 Eutaw Place, Secretary, H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society—President, L. W. Hall, M.D., 10 Peterboro Street. Vice president,

By Professor ROBERT KIENBÖCK, Vienna
A volume of 450 pages, with 215 illustrations. Published by Urban & Schwarzenberg, Berlin, 1936. Price RM 24.00

This volume deals with those conditions which the author calls degenerative diseases of the vertebrae and which he has classified as follows

- 1 Scheuermann's adolescent kyphosis
- 2 Deforming spondylarthrosis
- 3 Osteoporotic kyphosis

These subjects are each discussed as to etiology, diagnosis, and roentgenographic appearance and followed by various case reports together with their related roentgenograms

In the group of cases under the heading "deforming spondylarthrosis" are various lesions such as hematoma of the vertebrae producing secondary changes, but for the most part the author feels that these degenerative changes are secondary to adolescent kyphosis

The author has presented a diagnostic atlas of these conditions obviously for use mainly by roentgenologists and those interested in the roentgenologic appearance of these lesions. Nearly every variation one may find in these conditions is presented. Whether one agrees with the diagnostic findings in all cases does not matter so much, as the material on each case is well presented and one may draw his own conclusions

The illustrations are for the most part good though in many instances are not as clear as one would desire in such an atlas of roentgenology. The bibliography is quite complete. The volume is a very useful one for reference though by itself it covers a small part of the subject of x-ray diagnosis of conditions of bones and joints

RADIOTHERAPIE GYNECOLOGIQUE (Gynecologic Radiotherapy), CURIE- ET RÖNTGENTHERAPIE (Radium and Roentgen Therapy). By R. MATHEY-CORNAT, Radiologiste de Hôpitaux, Médecin de la Fondation Bergonié (Centre anticancéreux de Bordeaux et du Sud Ouest), Chef du Service central d'Electroradiologie des Hôpitaux du Groupe Pellegrin-Le Tondou. A volume of 309 pages, with 84 illustrations. Published by Masson et Cie, Paris, 1936. Price 60 francs

This book intends to present to radiologists, general men, surgeons, and gynecologists the

essential facts in regard to gynecologic radiotherapy and at the same time to give them up-to-date information on the progress that is being made in this very important branch of the therapy of diseases of the female genital tract. To this end the author has eliminated non essential and theoretic conceptions and has made the subject matter primarily clinical

The book opens with a section on the fundamentals of gynecologic radiotherapeutic technique. There follows a chapter on benign lesions of the female genitalia. The third chapter is about disturbances of the endocrine glands and menstrual disorders. There then follow chapters on various gynecologic diseases with special emphasis laid on malignant tumors. Like many European authors, Mathey-Cornat includes carcinoma of the breast. The author cites 363 references in his bibliography and closes with an extensive index. The whole makeup of the book is excellent. Any physician who wishes to be conversant with gynecologic radiotherapy may well read this book with interest and profit

CUTANEOUS CANCER AND PRECANCER. A practical monograph, by G. M. MACKEE, M.D., Professor of Clinical Dermatology and Syphilology and Director of Skin and Cancer Unit, New York Post-graduate Medical School and Hospital, Columbia University, and ANTHONY C. CIPOLLARO, M.D., Associate in Dermatology, Skin and Cancer Unit, New York Post-graduate Medical School and Hospital, Columbia University, with a Foreword by FRANCIS CARTER WOOD, M.D. A volume of 223 pages, with 245 illustrations. Published by The American Journal of Cancer, New York, 1937. Price \$3.75

This practical monograph on cutaneous cancer and precancerous dermatoses is divided into four chapters. The first chapter, very brief, deals with the morbidity and mortality of cutaneous cancer. The second chapter deals with precancerous dermatoses, covering some ninety pages. The third chapter deals with cutaneous malignancies, dividing them into two main groups, carcinoma and sarcoma, covering about ninety pages. The third chapter, as well as the second, has a rather extensive bibliography. The fourth chapter contains a survey of the established therapeutic methods. It covers briefly the surgical, chemical, and physical means of therapeutics.

The subject matter is concise and conveni-

TENNESSEE

Memphis Roentgen Club—Chairmanship rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

Tennessee State Radiological Society—President, H S Shoulders, M D 246 Doctors Bldg, Nashville Vice president, S S Marchbanks, M D, 508 Medical Arts Bldg, Chattanooga, Secretary-Treasurer, Franklin B Bogart, M D, 311 Medical Arts Bldg, Chattanooga Meeting annually with State Medical Society in April

TEXAS

Texas Radiological Society—President, R G Giles, M D, Medical Arts Bldg, San Antonio, President-elect Jerome H Smith, M D, Shannon West Texas Memorial Hospital, San Angelo First Vice-president, C F Crain, M D, 416 Chaparral St, Corpus Christi, Second Vice-president M H Glover M D, 904 8th St, Wichita Falls, Secretary-Treasurer, G D Carlson M D, 3121 Bryan St Dallas Meets annually San Antonio is next place of meeting

VERMONT

See New England Roentgen Ray Society

VIRGINIA

Radiological Society of Virginia—President, Fred M Hodges, M D, 100 W Franklin St, Richmond, Vice president, L F Magruder M D, Raleigh and College Aves, Norfolk, Secretary, V W Archer, M D, University of Virginia Hospital, Charlottesville

WASHINGTON

Washington State Radiological Society—President, H E Nichols, M D, Stimson Bldg Seattle, Secretary, T T Dawson, M D Fourth and Pike Bldg, Seattle. Meetings fourth Monday of each month at College Club

WISCONSIN

Milwaukee Roentgen Ray Society—Secretary, S A Morton, M D, Columbia Hospital, Milwaukee Meets monthly on first Friday

Radiological Section of the Wisconsin State Medical Society—Secretary Russel F Wilson, M D, Beloit Municipal Hospital, Beloit Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September

University of Wisconsin Radiological Conference—Secretary, E A Pohle, M D 1300 University Ave, Madison, Wis Meets every Thursday from 4 to 5 p.m Room 301 Service Memorial Institute

Associate Professor of Roentgenology and Cardiologist, Department of Medicine, Temple University School of Medicine, Cardiologist, Temple University Hospital, Consulting Cardiologist, Shriner's Hospital for Crippled Children, Philadelphia. A volume of 343 pages containing 198 illustrations. Published by Charles C Thomas, Springfield, Illinois, 1937. Price \$7 50

For many years the American literature has suffered for want of a comprehensive text concerning roentgenology of the cardiovascular system and it is doubtful if this method of examination has been adequately appreciated by the average clinician and roentgenologist in this country. Roesler, because of his ability as a cardiologist and a keen radiologist, has presented the subject in a manner that could be approached by few other authors. The arrangement of the text is excellent and the order of presentation, beginning with the fundamentals of the subject and working up to the clinical applications, bespeaks the experience of a good teacher. Because of the detailed manner in which the subject has been considered the text cannot be read with rapidity. The slower and more patient "small dose" method of study was found more practical.

This excellent text, together with its voluminous bibliography, will unquestionably remain as a fundamental work concerning roentgenology of the cardiovascular system for some time to come. It is recommended without reservation for roentgenologists, clinicians, and students.

RADIOLOGICA (International Journal of Photobiology and Biophysics, Medical Radiology and Photochemistry). Edited by H. JAUSION, Paris, J. PLOTNIKOW, Zagreb, H. SCHREIBER, Berlin. Published by Walter de Gruyter & Company, Berlin W35, Woyrschstrasse 13, Germany. Price 35 RM per volume less 25 per cent outside of Germany.

This is a new journal scheduled to appear as three volumes annually, each volume to consist of six pamphlets (about 18 pages). It is the purpose of this new publication to summarize in review form original contributions pertaining to photobiology, biophysics, medical radiology, and photochemistry. The original articles will appear in French, German, English, or Italian. A summary of each article will be printed in English, German, and French. There will also be a section con-

taining a summary of all important work in the literature. Contributors will be reimbursed at the rate of 30 RM for each printed page and manuscripts should be sent to the Chief Editor, Doctor Hans Schreiber, Berlin-Friedenau, Cecilienstrasse 45, Germany. In the next volume 32 papers will appear. A sample copy of this journal contains articles on the following subjects:

- Heliotherapy of Lupus Tuberculosis (French),
- A Radiometric Method of Measuring Ultra violet Solar Radiation Intensities in the Stratosphere (English),
- Biologic Significance of Reflected Ultra-violet Rays (German),
- Physicochemical Studies on *Melanins* (English)
- Spectrographic Researches Concerning Irradiated Substances (Italian),
- Roentgen Therapy with High Voltage (French),
- The Absorption of Short Wave Energy in Biological Tissues (German)
- Activation by Light of the Immunizing Function of the Skin (French)

DIATHERMY Third Edition. By ELKIN P. CUMBERBATCH, M.A., B.M. (Oxon.), D.M.R.E. (Camb.), F.R.C.P., Medical Officer in Charge of Electrical Department and Lecturer on Medical Electricity, St. Bartholomew's Hospital. A volume of 560 pages, with 168 illustrations. Published by William Wood & Company, Baltimore, Maryland, 1937. Price \$6 00.

The author, in collaboration with nine workers in special fields, has written a third edition on the subject of medical and surgical diathermy. The rapid advance in knowledge of diathermy and the progress that has been made in medical and surgical uses of high frequency currents have rendered it necessary to compile this new and enlarged volume on the subject.

The book is divided into three parts, the first of which is concerned with the evolution of diathermy and the physical principles underlying the production of high frequency currents. The second and third parts cover the subjects of medical and surgical diathermy, respectively.

The author has selected and described in detail several machines required for various types of treatment, and has discussed each method of treatment. Rather brief chapters are included regarding treatment by ultra-short waves and by induction cables. It is apparent that the conventional type of diathermy is still the most

RADIOLOGICAL SOCIETIES

beth's Hospital, Youngstown, *Secretary-Treasurer* Harry Hauser, M D Cleveland City Hospital, Cleveland Meetings at 6 30 P M at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April inclusive

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists) — *President*, George Benzing, M D, St. Elizabeth Hospital, Covington Ky *Secretary-Treasurer* Justin E McCarthy, M D 707 Race St, Cincinnati, Ohio Meetings held third Tuesday of each month

PENNSYLVANIA

Pennsylvania Radiological Society — *President*, Sydney J Hawley, M D, Geisinger Memorial Hospital, Danville, *First Vice president*, William J McGregor M D 744 Franklin Ave, Wilkesburg, *Second Vice-president*, Oscar M Weaver, M D, 12 S Main St Lewistown, *Secretary-Treasurer*, Lloyd E Wurster M D, 416 Pine St, Williamsport, *President elect* Charles S Caldwell, M D, 520 S Aiken Ave, Pittsburgh Annual meeting May, 1938 Exact date and place to be decided

Philadelphia Roentgen Ray Society — *President*, Thomas P Laughery, M D, Germantown Hospital *Vice president*, Elwood E Downs, M D Jeans Hospital, Fox Chase, *Secretary*, Barton H Young, M D Temple University Hospital, *Treasurer* R. Manges Smith, M D, Jefferson Hospital Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S 22nd St, 8 15 P M

The Pittsburgh Roentgen Society — *President* F L Schumacher, M D, Jenkins Arcade, *Secretary*, H N Mawhinney, M D, Mercy Hospital Two Fall and two Spring meetings at time and place designated by president

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

South Carolina X-ray Society — *President*, Robert B Taft M D, 105 Rutledge Ave, Charleston, *Secretary-Treasurer* Hillyer Rudisill, M D Roper Hospital Charleston Meetings in Charleston on first Thursday in November also at time and place of South Carolina State Medical Association

SOUTH DAKOTA

Meets with Minnesota Radiological Society

ANIMAL EXPERIMENTATION

The Behavior of the Reticulocytes of the White Mouse after Roentgen Therapy H Langendorff Strahlentherapie, 1937 59, 652

The author continued his studies dealing with the effect of roentgen rays on the reticulocytes of mice Technique 180 kv 4 ma 30 cm FSD HVL_u = 0.85 mm, exposure of from 1 to 9 minutes The doses applied and the intervals between treatments were varied It appeared that the degree of radiation effect following simple fractionated doses of roentgen rays does not only depend on the total dose but also on the amount and order of each single dose as well as on the spacing The maximum effect was observed if each following exposure was given at the height of the reaction from the previous treatment This manifested itself in a constant increase of the number of reticulocytes

ERNST A POHLE M D, Ph D

Microcinematographic Studies of the Effect of Roentgen Rays on Normal and Tumor Cells in Tissue Cultures H Volinar and B Rajewsky Strahlentherapie, 1937, 60, 524

The authors exposed cultures of normal (chicken embryo) and pathological tissue (mouse carcinoma) to roentgen rays Technique 21 kv 30 ma 16 r/min 480-2580 r total dose Some of the microscopic observations were recorded by a motion picture film It appeared that the single cells constituting a cell complex showed very different reactions to irradiation This expressed itself in the reaction speed as well as in the type of injury following exposure photomicrograms are appended demonstrating this observation Studies of the growth of an irradiated culture during irradiation itself seemed to point to a primary localized effect of irradiation The authors could also prove experimentally the fact that while certain cells in a cell complex were markedly injured others escaped injury entirely

ERNST A POHLE M D Ph D

The Action of Marconi therapy on Experimental Peritonitis from *B coli* Leopoldo Giacobbi Archivio di Radiologia, 1937 15, 220-225

Rabbits in which peritonitis had been produced were treated with short wave diathermy It was found that the treated animals lived longer than the controls but no histologic changes could be found in them

E T LEDDY M D

ARTHRITIS

Non-traumatic Protrusion of the Acetabulum A Mayoral Southern Med Jour December 1937 30, 1163-1165

A case of Otto's pelvis is reported developing in two years time following a low grade arthritis of the hip

The patient was a man, bed ridden and the lesion was in the hip joint of a leg which had been amputated at the thigh The author concludes that infection and muscle action play an important rôle in the development of this condition

JOHN M MILES M D

BLOOD CHANGES

The Effect of Roentgen Rays on Erythropoiesis K Mardersteig Strahlentherapie 1937, 59, 609

The author studied the influence of roentgen radiation given in therapeutic doses on the reticulocytes of human blood His conclusions are based on observations made in 13 patients with carcinoma of the bronchus one with carcinoma of the esophagus two with carcinoma of the liver six with carcinoma of the stomach, six with metastatic bone carcinoma, six with myelocytic leukemia and five cases with lymphocytic leukemia The customary deep therapy technique was used and applied according to the method of Holfelder It appeared that following a temporary stimulation a definite inhibition of the erythropoietic function occurred and was balanced by regeneration from the bone marrow In patients in whom the bone marrow function has been disturbed by the malignant disease this regeneration is either insignificant or does not take place at all If bone marrow regeneration is noted at the beginning of the treatment the prognosis is usually poor The same holds true if the reticulocytes are increased before irradiation, indicating a hyperfunction of the red bone marrow The determination of the reticulocytes was of no prognostic value in the irradiated cases of myelocytic leukemia However in patients with lymphocytic leukemia who responded well to irradiation the erythropoietic function was increased

ERNST A POHLE M D Ph D

BONES (DISEASES)

Paget's Disease with Unusual Findings Giuseppe Bonifazi Archivio di Radiologia 1937 15, 217-219

The author reports a case of Paget's disease in which the diagnosis was possible only by roentgenogram which he reproduces The patient a woman of 52 had had pain and lameness in the hip and back for eight years with a negative examination except as above cited

E T LEDDY M D

BREAST CANCER

Gingival Metastasis from Cancer of the Breast M Lüdén Strahlentherapie 1937 60, 304

The author reports a very unusual case of a gingival metastasis originating from a primary carcinoma in the breast The patient first noticed a loosening of the last left lower molar and then in the surrounding gingiva

International Expositions of Medicine Medical Edition A volume of 300 pages Published by Norbert Maloine, 27 Rue de l'Ecole de Medicine, Paris, 1932 Price (not known)

RADIOPHYSIOLOGY AND RADIOTHERAPY Review of Biological Studies Technics, and Therapeutics Published by CL REGAUD, Director, A LACASAGNE, Associate Director and R FLRROUZ, Chief Physicist of the Laboratory of Radiophysiology of the Radium Institute (Archives of the Radium Institute of the University of Paris and the Curie Foundation) A volume of 188 pages Issued by Les Presses Universitaires de France, March, 1937 Price 50 fr

POST OPERATIVE RADIOLOGICAL EXAMINATION OF THE COMMON BILE DUCT By B DESPLAS, P MOULONCULT and P MALGRAS A volume of 120 pages with 40 figures Published by Masson et Cie, Paris 1938 Price 40 fr

PHYSIOTHERAPY, ORGANIZATION FOR WORLD PEACE Souvenirs, Documents By A JOSEPH RIVIERE The conceptions the works, the facts, the acts, and dates Published by Imprimerie et Librairie Centrales Societe Rue Bergere 20 Paris, 1937 Price (not known)

INJURIES OF THE FOOT AND X RAYS Malleoli, Astragalus Calcis the Fore foot By ETIENNE DESTOT Preface by DR ALEXIS CARREL Second Edition A volume of 292 pages with 156 figures Published by Masson et Cie, Paris, 1937 Price 45 fr

BOOK REVIEWS

OUTLINE OF RADIOLOGY Prepared and published by the Educational Committee of the Pennsylvania Radiological Society Sidney J Hawley, M D, *Chairman*, John T Farrell, Jr, M D, Harold W Jacob, M D, Zoe A Johnston, M D, Forrest L Schumacher, M D, James J Quiney, M D, and James L Weatherwax, M A, 1937 A litho-printed and paper bound volume of 126 pages Price \$3 00 (Order from Sidney J Hawley, M D, Geisinger Memorial Hospital, Danville, Pennsylvania)

This Outline was prepared by the Educational Committee of the Pennsylvania Radiological Society to complement a systematic review of radiology which was started by that Society in May, 1936 This Outline is not intended to be a textbook of radiology, but rather a guide for study The Committee has outlined the more important conditions in such a way that a physician studying the subject will have a guide and readily available bibliography of the more important articles concerning each

ANIMAL EXPERIMENTATION

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ERNST A POHLE, M D Ph D

Microcinematographic Studies of the Effect of Roentgen Rays on Normal and Tumor Cells in Tissue Cultures H Vollmar and B Rajewsky *Strahlentherapie*, 1937, 60, 524

The authors exposed cultures of normal (chicken embryo) and pathological tissue (mouse carcinoma) to roentgen rays. Technic 21 kv, 30 ma, 16 r/min 480-2 880 r total dose. Some of the microscopic observations were recorded by a motion picture film. It appeared that the single cells constituting a cell complex showed very different reactions to irradiation. This expressed itself in the reaction speed as well as in the type of injury following exposure. Photomicrograms are appended demonstrating this observation. Studies of the growth of an irradiated culture during irradiation itself seemed to point to a primary localized effect of irradiation. The authors could also prove experimentally the fact that while certain cells in a cell complex were markedly injured others escaped injury entirely.

ERNST A POHLE M D Ph D

The Action of Marcoll therapy on Experimental Peritonitis from *B coli* Leopoldo Giacobbi *Archivio di Radiologia* 1937 15, 220-225

Rabbits in which peritonitis had been produced were treated with short wave diathermy. It was found that the treated animals lived longer than the controls but no histologic changes could be found in them.

E T LEDDY M D

ARTHRITIS

Non traumatic Protrusion of the Acetabulum A Mayoral *Southern Med Jour* December 1937 30, 1163-1165

A case of Otto's pelvis is reported developing in two years time following a low grade arthritis of the hip.

The patient was a man bed ridden, and the lesion was in the hip joint of a leg which had been amputated at the thigh. The author concludes that infection and muscle action play an important role in the development of this condition.

JOHN M MILES M D

BLOOD CHANGES

The Effect of Roentgen Rays on Erythropoiesis K Mardersteig *Strahlentherapie* 1937, 59, 609

The author studied the influence of roentgen radiation given in therapeutic doses on the reticulocytes of human blood. His conclusions are based on observations made in 13 patients with carcinoma of the bronchus, one with carcinoma of the esophagus, two with carcinoma of the liver, six with carcinoma of the stomach, six with metastatic bone carcinoma, six with myelocytic leukemia, and five cases with lymphocytic leukemia. The customary deep therapy technic was used and applied according to the method of Holfelder. It appeared that following a temporary stimulation a definite inhibition of the erythropoietic function occurred and was balanced by regeneration from the bone marrow. In patients in whom the bone marrow function has been disturbed by the malignant disease this regeneration is either insignificant or does not take place at all. If bone marrow regeneration is noted at the beginning of the treatment the prognosis is usually poor. The same holds true if the reticulocytes are incurred before irradiation indicating a hyperfunction of the red bone marrow. The determination of the reticulocytes was of no prognostic value in the irradiated cases of myelocytic leukemia. However in patients with lymphocytic leukemia who responded well to irradiation the erythropoietic function was increased.

ERNST A POHLE M D Ph D

BONES (DISEASES)

Paget's Disease with Unusual Findings Giuseppe Bonifazi *Archivio di Radiologia*, 1937 15, 217-219

The author reports a case of Paget's disease in which the diagnosis was possible only by roentgenogram which he reproduces. The patient a woman of 52 had had pain and lameness in the hip and back for eight years with a negative examination except as above cited.

E T LEDDY M D

BREAST CANCER

Gingival Metastasis from Cancer of the Breast M Ludin *Strahlentherapie* 1937 60, 304

The author reports a very unusual case of a gingival metastasis originating from a primary carcinoma in the breast. The patient first noticed a loosening of the last left lower molar and then in the surrounding gingiva.

physician will enter into whatever practice his fancy or his apparent necessities direct him, regardless of his qualifications. Emphasis in the short course must be placed primarily upon the broader aspects of radiology as applied to medical practice but attention should also be given to technique and method. The exercise of reasonable discretion in the choice and presentation of these subjects will tend to improve medical practice with very little possibility of coincident harmful results.

LEO G. RIGLER, M.D.

ANNOUNCEMENT

SCIENTIFIC EVENT

The Third International Cancer Congress, under the auspices of the International Union against Cancer, will be held in the United States, September 11 to 16, 1939, at the Hadron Hall Hotel, Atlantic City, N. J.

The president of the Congress is Professor Francis Carter Wood, M.D., Director of the Institute of Cancer Research of Columbia University, New York City. Donald S. Childs, M.D., of Syracuse, N. Y., is Secretary-Treasurer, and A. L. Loomis Bell, M.D., of Long Island College Hospital, Brooklyn, N. Y., is in charge of transportation and exhibits.

The proposed sections are as follows: General research, biophysics, genetics, general pathology of cancer, surgery of cancer, radiological diagnosis of cancer, radiotherapy of cancer, statistics, and education. Further details concerning section chairmen, committees, and other data will be announced later.

The membership fee will be \$15. All inquiries should be addressed to the Institute of Cancer Research, 1145 Amsterdam Avenue, New York City.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CLINICAL OUTLINE OF PHYSIOTHERAPY. Rational Treatment of Chronic Maladies. By A. JOSEPH RIVIERE. Doctor of Medicine of the Faculty of Paris, D.S.C. (*honoris-causa*) of the Lincoln Memorial University, U.S.A. Editor in chief of 'Annals of Physiotherapy'. Gold Medal from the National and

poor After two minutes of adaptation one third of the persons examined were insufficiently adapted and could not see any numbers, only four had become adapted to the best possible degree after two minutes. All others needed ten minutes. There are persons who show a fast adaptation and a very acute vision in the dark, but others show slow adaptation and very poor vision, even after ten minutes.

Only six of 30 physicians passed the test as good. 10 had a medium grade and 14 a poor one. Only about one fifth of the examined persons had good vision in the dark, one third medium, and one-half poor.

The authors conclude that it would be advisable to test in the dark the visual acumen of physicians who are supposed to do chest fluoroscopy, especially when fluoroscopy is used as the only roentgen examination of the chest.

HANS W. HEFKE, M.D.

FRACTURES

Contribution on Traumatic Epiphyseal Separation of the Distal End of the Leg. C. F. Giegy, Schweiz med. Wchnschr., July 10, 1937, 67, 626, 627.

The author reports the results of follow up of ten separations of the tibial epiphysis and seven of the fibular, of which fourteen and six respectively, were followed. The injuries were divided into two classes: abduction-pronation separations with a wide medial separation in the tibia, a small chip fracture laterally (two cases), and a supra malleolar fibular fracture, and adduction-supination separation with slight separation of the tibial epiphysis, more marked of the fibular, and sometimes in adults a fracture of the medial malleolus.

Treatment consisted of reduction and immobilization in U splints or plaster for from five to six weeks. Excellent functional results were obtained in all cases.

L. G. JACOBS, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Stimulative Action of Other Parts of the Gastro-intestinal Tract on the Colon. Demetrio Messuti. Archivio di Radiologia, 1937, 15, 198-216.

The author studied roentgenologically the stimulative action exercised on the colon by the stomach and small intestine both after fasting and after food. He found that the digestive processes in the colon were all accelerated after the entrance of food higher up in the alimentary canal.

E. T. LEDDA, M.D.

The Relative Importance of Food Idiosyncrasy in Gastro-intestinal Diseases. William C. Chaney. Southern Med. Jour. December 1937, 30, 1185-1188.

Gastro-intestinal allergy, a true tissue hypersensitivity to certain foods, occurs more frequently than is generally thought. The history, trial diets, skin tests,

search for eosinophils in the stool and nasal secretions, and the x-ray constitute diagnostic approaches.

The x-ray findings are not characteristic of the condition, but help exclude organic pathology. The author urges a modified Graham-Cole examination with the fat meal consisting of cream, eggs, wheat bread, and hot chocolate. These four foods are those which most frequently produce allergic reactions. If, after this meal, the patient develops severe abdominal pain with later an urticaria, allergy is considered. If the roentgenologist reports the gall bladder functioning satisfactorily, the evidence in favor of allergy is made stronger.

JOHN M. MILES, M.D.

GASTRO-INTESTINAL TRACT (THERAPY)

Gastro-intestinal Dysfunction. Barton A. Rhinehart. Southwestern Med. November, 1937, 21, 391-398.

Gastro-intestinal dysfunction, as defined by the author, applies to conditions of the alimentary canal which are not the result of organic changes. It includes dyspepsia, colitis, chronic gastritis, nervous indigestion, etc.

All the symptoms are due to increased irritability or increased functional activity of neural and muscular tissues. The symptomatology is identical with that of tetany. The common factor in this group of disorders is nutritional deficiency and this is chiefly of calcium and vitamin D.

The treatment recommended is rest, correction of nutritional deficiencies, and surgical correction of localized disease complications. Plenty of meat, milk, and sunshine and the avoidance of excess of fruits, vegetables, and physic medicines are advised.

JOHN M. MILES, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Development of a Hydronephrosis by an Aberrant Vessel. R. Bauer. Röntgenpraxis. March, 1937, 9, 160-163.

The author found pyelographic evidence of an accessory or aberrant vessel at the uretero-pelvic junction in 16 out of 216 cases. Six times the finding was bilateral, ten times unilateral. In some cases a marked hydronephrosis develops gradually.

Conservative surgery seems indicated in the greater number of such cases. The hydronephrosis becomes slowly less marked after the obstruction has been removed by surgery. Nephrectomy is indicated only when there is very marked destruction of the kidney substance.

An intravenous pyelogram is at times of greater diagnostic value than a retrograde pyelogram which causes some unphysiologic distortion of the ureter due to the introduction of a catheter.

HANS W. HEFKE, M.D.

sidered from both the roentgenologic and the clinical points of view and interesting or illustrative roentgenograms are introduced to supplement the text. Kienbock often introduces new terms which have little superiority over the older, commoner ones, and in many instances they confuse the reader. The booklet is of interest primarily to roentgenologists and orthopedists, and to students wishing to become as well grounded as possible in this very confusing field.

THEORETICAL PRINCIPLES OF ROENTGEN THERAPY Edited by ERNST A. POHLE, M.D., Ph.D., F.A.C.R., Professor of Radiology, Chairman, Dept. of Radiology and Physical Therapy, University of Wisconsin. Contributors: R. R. Newell, M.D., Professor of Medicine (Radiology), Stanford University Medical School; K. Wilhelm Stenstrom, Ph.D., Professor of Biophysics, University of Minnesota Medical School; Ernst A. Pohle, M.D., Ph.D., Lauriston S. Taylor, Ph.D., Physicist, Bureau of Standards, Washington, D.C.; Francis Carter Wood, M.D., Director, Institute of Cancer Research, Columbia University. Foreword by W. Edward Chamberlain, B.S., M.D., F.A.C.R., Professor of Radiology, Temple University School of Medicine, Philadelphia. A volume of 272 pages, with 132 illustrations. Published by Lea & Febiger, Philadelphia, 1938. Price \$4.50.

In this book, which is dedicated to the memory of his former Chief, the late Preston M. Hickey, Pohle has collected and edited a series of chapters by recognized authorities on the theoretical foundations of roentgen therapy. In a brief foreword, Chamberlain points out the close linkage between physicist and physician in this ever-expanding field to the mutual advantage of both. Stenstrom's chapter on the physics of roentgen rays (pages 17-59) boils down to the essential facts: the structure of the atom, the properties and nature of cathode rays, roentgen rays, their properties and quantitative and qualitative measurements, and treats the material from a descriptive rather than a mathematical point of view. Newell (pages 61-115) takes up roentgen-ray apparatus, with special reference to the up-to-date developments, including supervoltage and artificial radio-activity. Notwithstanding the complexity of the subject, Newell's presentation is in all essentials complete, and in addition is replete with sane, conservative observations. One may be quoted: "Patients will

inevitably assume that if 200 kv will almost cure cancer, surely 1,000,000 v will cure it easily. That is a proposition which will take a deal of proving! We will be wise to look carefully at the experience of the places now using supervoltage before we set up these costly installations everywhere. The advertising value of even 500,000 v, however, is bound to prove enormously tempting. Will patients and their physicians have the wisdom to inquire, not 'how many volts' but 'what is the training and experience of the radiologist?'" Taylor and Pohle collaborate on the chapter on dosimetry (pages 121-178). They discuss units of quality and quantity and describe apparatus for their measurements. The determination of the "clinical dose" is treated at due length and with suitable detail. Various methods of treatment are sketched. The importance of adequate records is illustrated by samples. Wood (pages 188-227) discusses the biologic foundations of roentgen therapy, a subject of the greatest clinical importance. He considers the underlying physical foundations of the radiation effect and the action of radiation on normal and pathologic cells, and exemplifies them with excellent illustrations. The final chapter on protection by Taylor (pages 233-260) takes up protection against direct and scattered radiations and materials for this purpose. The recommendations of the Advisory Committee on X-ray and Radium Protection are given *verbatim*.

The arrangement of the book is excellent and the illustrations are well chosen and well reproduced. The bibliography is adequate.

Pohle's aim is to serve two groups of readers: the radiologist, who must have a thorough understanding of the theoretical principles underlying roentgen therapy, and the research worker, who is not interested in the clinical application of roentgen rays.

In my opinion Pohle's aim was so good that he has hit the center of the bull's eye.

In spite of considerable thought I can offer no destructive criticism of any part of the book. I know no place else where one can find so much important material in so small a space. To all interested in roentgen therapy the book can be recommended without reservations.

RÖNTGENDIAGNOSTIK DER KNOCHEN UND GELENKKRANKHEITEN (Roentgen Diagnosis of Bone and Joint Diseases) Volume IV, Degenerative Diseases of the Vertebrae

the determination of the structure involved. For example, through radiological diagnosis more information concerning the anatomical involvement in a case of pneumonia can be ascertained than by any or possibly all other methods combined. The radiologist must not forget, however, that as physicians our chief interest is not with deranged structure, but in the disturbance of function. In the case of acute lobar pneumonia and in many other important diseases, it is not enough to determine the amount of structure involved, one must, in addition, know the type of organism, if the blood stream has been invaded, or if the anatomical involvement is an incident to a pre-existing chronic ailment, and, if so, its character, leading complications, etc. Metaphorically speaking, the dead hand of Virchow still rests on the profession. We are so prone to designate the disease and cease further diagnostic investigation. The patient as a human being must be considered. He possesses a soul or a spirit or whatever you wish to call it. An example of medical neglect is Christian Science. Physical cultists and dietetic pseudo-experts reflect other aspects of medical indifference. It has been said that a physician caring for a patient and neglecting the emotional life is as unscientific as the investigator who neglects to control all conditions affecting his experiment. By this I do not infer that serious consideration of the disease and its treatment are not required, as is so obvious in diseases such as pneumonia, cancer, etc., but when the corner is turned and the immediate crisis over, then you must give your deepest attention to the patient.

It appears that we could do nothing more useful at this time, for the future of radiology as a division in the practice of medicine, than to stress the attitude toward the patient of those engaged in this specialty. We should urge that such consideration begin during the courses in undergraduate medical education.

Radiology, like all other divisions of medicine, has two general divisions among those engaged, the research workers and

those in practice. In the beginning, research was most essential, but at present it becomes imperative that the practice of radiology be carefully analyzed and directed.

Whenever the problems concerned with the practice of any division of medicine are considered, there emerge for discussion two common factors, the patient and the doctor. For this, it is indeed but little different whether it be in connection with the practice of radiology, general practice of medicine, specialism, contract practice, state medicine, cost of medical care, health insurance, hospitalization plans, or whatnot. It is only natural that, if we accept our place as a group, practising a specialty in medicine, we must be guided by the principles of practice governing the other divisions.

To define just what shall be included in the practice of radiology and the exact status of the relation between the radiologist and the patient involves some very delicate, yet important, considerations. It is unfortunate perhaps that this differentiation must be created at a time when medicine is in so perilous a state of storm and stress. This uncertainty is not confined, however, to medicine. While looking about us we see that thrones are toppling, constitutions are being modified or scrapped, economic conditions becoming more unsettled, industrial and special groups are hostile, nations are angry and brandishing dangerous weapons, in fact, the whole structure of our civil organization seems to be threatened and the tranquility and stability of the future uncertain. It would be rash indeed to venture to predict what may be the status of medicine, or the relation between the patient and physician a century from now, or even a decade hence.

As our specialty becomes more stabilized, we see roughly two divisions in practice: one in which the radiologist's entire time is devoted to patients in group practice and his clientele referred, the other in which a portion or all of the radiologist's clientele is private and he directs the entire

ently arranged, and offers an excellent résumé of the subjects of cutaneous cancer and precancerous dermatoses. Each pathological condition is discussed from the clinical standpoint, anatomical and histopathological illustrations are presented, and therapeutic suggestions are made.

The book is extremely valuable for its numerous anatomical and histopathological illustrations, and its able presentation. This monograph should be of interest particularly to the dermatologist and therapeutic radiologist.

GASTROSCOPY THE ENDOSCOPIC STUDY OF GASTRIC PATHOLOGY By RUDOLPH SCHINDLER, M.D., Associate Clinical Professor of Medicine, University of Chicago, Attending Gastroscopist, Michael Reese Hospital, Consulting Gastroscopist, Cook County Hospital, Chicago. A volume of 343 pages, with 89 text illustrations and 97 color reproductions. Published by The University of Chicago Press, Chicago, 1937. Price \$7.50.

According to the author, the exact anatomic diagnosis of gastric disease became possible with the introduction of two morphologic methods—roentgenology and gastroscopy. Although gastroscopy is older, its perfection has been more recent. The purpose of this book is to demonstrate that gastroscopy is similarly indispensable in the diagnosis and treatment of gastric disease. Whether or not one agrees entirely with the author's opinion, it cannot be denied that he knows his subject and has presented it in a most comprehensive and understandable manner. Roentgenologists will do well to study this text, not with the idea of hoping to master the method, but in order to better realize some of the deficiencies of their own method of examination, and the limitations of the procedure under discussion.

In a discussion of some of the optical problems of gastroscopy the author emphasizes that "negative findings in gastroscopy do not exclude the presence of a pathologic lesion, because it is not possible to be certain in each case that all of the gastric wall has been seen. The flexible gastroscope has lessened some of these difficulties but it is impossible, even in the most favorable case, to be sure that one has seen every small lesion." This is due to the fact that mechanical and optical limitations create certain blind spots the extent of which may vary in individual cases. The antrum, angu-

lus, and pylorus are seen with the flexible gastroscope in about 90 per cent of all cases. The pylorus can almost always be observed by a skillful gastroscopist although the lesser curvature of the antrum often remains hidden from view. The lower pole of the stomach always contains a sector which is not seen because the objective looks sideward. Lesions of the cardia are best seen with the esophagoscope and should form a contra-indication to the use of the gastroscope. That part of the cardia which is immediately adjacent to the objective, especially at the side of the lesser curvature, cannot be seen even with retrograde systems.

The technique of gastroscopy is discussed in great detail and definite contra-indications emphasized. Under indications for the procedure the author states that gastroscopy should be a routine method of the gastroenterologist. This is probably an idealistic attitude because if gastroenterologists have the same difficulty in mastering the procedure as many have had in becoming proficient in roentgenologic procedures, the examination will have little dependable value as a routine except in the hands of experts.

The chapters relating to ulcers, gastritis, and tumors are particularly informative and bespeak the wide experience and keen observation of the author.

Roentgenologists will be especially interested in the chapter concerning the relationship between gastroscopy and x-ray. In the minds of expert examiners some variances of opinion will be incited. The subject is rightfully summarized, however, by the statement, "Gastroscopy and x-ray, when used together are not mutually exclusive, but on the contrary, should be used together."

The author has written a classic text concerning a procedure which bids fair to influence the diagnosis and treatment of many cases of gastric disease. Some parts are colored by the enthusiasm of an active pioneer but others reveal a frank conservatism that is commendable. It should be read and studied by all concerned with the diagnosis and treatment of gastric disorders.

CLINICAL ROENTGENOLOGY OF THE CARDIOVASCULAR SYSTEM ANATOMY, PHYSIOLOGY, PATHOLOGY, EXPERIMENTS AND CLINICAL APPLICATIONS. By HUGO ROESLER, M.D.,

the patient with an order from the doctor to "ray the elbow for me" or "give him a couple of shots of Coolidge on the eczema about a week apart" The public conception of radiology in the practice of medicine is indeed very largely determined by the personal attitude of the radiologist in his relations with the individuals when they receive medical service from those engaged in this specialty

The radiologist who undertakes the bedside manner of practice, becomes the patient's doctor and assumes the obligations of the medical management, must study and develop the bedside manner of a physician This requires mutual understanding and confidence between the patient and the radiologist This confidence is a subtle thing and requires, on the part of the patient, complete truthfulness in disclosing all relevant facts, and, on the part of the doctor, absolute sincerity and as much truthfulness as is compatible with his other responsibilities In the interest of the patient he cannot always be completely frank Private communications may sometimes forbid, but his opinion and conclusions must be discussed frankly and truthfully with the patient or some immediate friend

At the bedside we must not disclose hesitation or doubt Remember, the patient studies the doctor's frame of mind and often watches anxiously for changes in his expression, voice, etc On the other hand, a radiologist should not beguile his patients, nor attempt to inspire their confidence by becoming an actor, for most patients are quite able to tell when self-confidence merges into self-conceit, and there are examples when it appears to become a megalomania

EDUCATION

The bedside manner in the practice of radiology enhances the value of medical radiology to the patient and it also creates the opportunity for its individual teaching in medical education It is true that the policy of group formation in medical practice is being urged upon the medical

profession at this time Obviously, as these groups multiply there will come to be group selection by the patients and ultimately this leads to mass treatment It is singular to note that, as this policy is being pressed upon us, analogous fields are rejecting it For example, until recently crime and insanity were treated almost exclusively by mass confinement in asylums and prisons Mass educational work was glorified For the relief of poverty, alms were dispensed to large groups in poorhouses, etc It seems that in all of these lines progress has been measured very largely by the extent to which individual personal relationships have supplanted mass measures Medical education is no exception Formerly large groups of medical students came day after day to the amphitheater for didactic lectures and operative demonstrations, but now we find small groups in close contact with the instructor in clerkships, ward walks, and in actual bedside teaching I would like to emphasize to those who are now teachers in under-graduate, as well as graduate, medical education, the importance of pointing out to their classes the great advantages of individual and bedside teaching in radiology We must remember that before long the older generation of teachers will be replaced by the younger men, and it is our duty to see that they possess the proper viewpoint.

The teaching of radiology involves something concerning the bill for services The work of the professional men in the administration or medical service is often inappropriately measured in dollars and cents In group practice the fees may seem more uniform and the relations between the radiologist and the patient, being more indirect, may ameliorate somewhat the difficulties concerned with financial settlements I do not mean that the collection of compensation for radiological services is not an obstacle to be surmounted by those in group practice It is, however, obvious that after a close relationship has been established between a physician and a patient, there is indeed no delight in re-

popular in the British Isles. The book may be criticized in that the experiments described have been inadequately controlled. For a topic that is highly technical, the book is written in a readable style.

This book can be recommended to any physician who desires information concerning conventional diathermy. The discussion on the newer short wave diathermy is, however, very limited.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Animal Experimentation	404	Epilepsy	405
Arthritis	404	Fluoroscopy	405
Blood Changes	404	Fractures	406
Bones (Diseases)	404	Gastro-intestinal Tract (Diagnosis)	406
Breast Cancer	404	Gastro intestinal Tract (Therapy)	406
Cancer (Therapy)	405	Genito urinary Tract (Diagnosis)	406
Dosage	405		

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

HANS W. HEFKE, M.D., of Milwaukee, Wis.	E. T. LEDDY, M.D., of Rochester, Minn.
L. G. JACOBS, M.D., of Madison, Wis.	JOHN M. MILES, M.D., of Houston, Texas.
ERNST A. POILLE, M.D., Ph.D., of Madison, Wis.	

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

BAUER, R. Development of a Hydronephrosis by an Aberrant Vessel	406	LÜDIN, M. Gingival Metastasis from Cancer of the Breast	404
BONIFAZI, GIUSEPPE. Paget's Disease with Unusual Findings	404	MARDERSTEIG, K. The Effect of Roentgen Rays on Erythropoiesis	404
CHANEY, WILLIAM C. The Relative Importance of Food Idiosyncrasy in Gastro-intestinal Diseases	406	MAJORAL, A. Non traumatic Protrusion of the Acetabulum	404
CHANTRAINE and CRAMER. Testing the Ability to See in the Dark	405	MESSUTI, DEMETRIO. The Stimulative Action of Other Parts of the Gastro intestinal Tract on the Colon	406
CRAMER, with CHANTRAINE, jt auth.	405	MOTIDA, N., with NAKAIDZUMI, M., jt auth.	405
FINSTERBUSCH, R., and SCHUMANN, G. Complete Destruction of a Humerus by Osteoclastic Carcinomatous Metastases	405	NAKAIDZUMI, M., and MOTIDA, N. Distribution of Roentgen ray Intensity during Irradiation with Convergent Beams	405
FISCHEL, EUGENIO. Some Factors in the Pathogenesis of Genuine Epilepsy as Determined Radiologically	405	RAJEWSKY, B., with VOLLMAR, H., jt auth.	404
GIACOBBI, LEOPOLDO. The Action of Marconitherapy on Experimental Peritonitis from <i>B. coli</i>	404	RHINEHART, BARTON A. Gastro-intestinal Dysfunction	406
GIBBY, C. F. Contribution on Traumatic Epiphyseal Separation of the Distal End of the Leg	406	SCHUMANN, G., with FINSTERBUSCH, R., jt auth.	405
HOLTHUSEN, H. Present Status of the Definition and the Measurement of the Dose	405	TRÜBESTEIN, H. The Absorption and Scattering of Monochromatic Roentgen Rays in Water, Triolein, Blood, Skeletal Muscle, and Subcutaneous Tissue of Man	405
LANGENDORFF, H. The Behavior of the Reticulocytes of the White Mouse after Roentgen Therapy	404	VOLLMAR, H., and RAJEWSKY, B. Microcinematographic Studies of the Effect of Roentgen Rays on Normal and Tumor Cells in Tissue Cultures	404

INTEGRATION OF CLINICAL AND ROENTGENOLOGIC FINDINGS IN THE DIAGNOSIS OF CARCINOMA OF THE ESOPHAGUS

A STUDY OF 100 CASES¹

By JOHN T. FARRELL, JR., M.D., Philadelphia

From the X-ray Department of the Jefferson Medical College and Hospital

HERE are few locations in which cancer is attended by such a hopeless prognosis as in the esophagus. Except in isolated cases, methods of treatment successfully employed in other organs are unavailing here. Irradiation, whether administered as radium or x-ray, has not been successful. At present, surgery probably offers the best method for coping with the condition. Surgical procedures in carcinoma of the esophagus are accompanied by high mortality, because usually when the patient is first seen the condition is so far advanced as to make surgery impossible.

This study was undertaken in an attempt to determine if correlation of the clinical and roentgenologic findings might reveal signs by which carcinoma of the esophagus could be diagnosed earlier and at a time when it would be amenable to surgery.

One hundred cases were selected, in 78 the histologic diagnosis was squamous-cell carcinoma, in 18 adenocarcinoma, and in four undifferentiated carcinoma. Thirteen of the tumors occurred in the upper third of the esophagus, 39 in the middle third, 39 in the lower third, and in nine the location was not determined. The clinical and roentgenologic data were analyzed as to sex, age, family history, serology, symptoms, and the roentgenologic findings.

Sex and Age—Ninety-three patients were males, seven were females (Table I).

Ages ranged from 20 to 80 years. There was one patient, a male, 20 years of age, 71 were between 50 and 70 years, and made up the largest group, of these, 34 were between 50 and 59 years, and 37 between 60 and 69. The number in these sixth and

seventh decade groups is higher than the percentage of cancer in other localities.

Family History—Only eight patients came from families in which some relative had suffered from cancer, 91 patients gave no history of malignancy, and in one

TABLE I—CARCINOMA OF ESOPHAGUS

Years	Sex and Age		Total
	93 Males	7 Females	
20-29	1		1
30-39	1		1
40-49	11	1	12
50-59	33	1	34
60-69	33	4	37
70-79	14	1	15

history there was no record. In only one instance was there more than one cancer recorded in the family history: a male, 64 years of age, had two sisters who died of cancer. In none of the family histories was there a record of cancer of the esophagus.

Serology—The reaction of the blood to the Wassermann or Kahn tests was recorded in 69 cases, in 31 it was not stated. There were 64 patients whose blood was negative and five with positive reactions.

Symptoms—Symptoms have been analyzed as to incidence, initial symptom, and duration of the initial symptom before diagnosis was made (Tables II and III).

Dysphagia was the most constant symptom and had the highest incidence as an initial symptom, 96 patients complained of it and 71 listed it as the first. Dysphagia was usually of gradual onset, difficulty being first experienced with solid food, and finally, as the disease progressed, difficulty with fluids also developed. Sometimes it was of sudden onset. Of the 71 patients in whom it was the first symptom, 38 (or

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

discovered a strawberry-colored growth with irregular surface which bled easily. Biopsy revealed an adenocarcinoma. Roentgen therapy was applied to the lesion directly and also through the outer skin. Technique 180 kv, 4 ma, 0.5 mm Cu + 1 mm Al, 230 r per sitting, total dose 2300 r. The tumor responded well to irradiation and at the end of an observation period of 15 months had not yet recurred.

ERNST A. POHLE, M.D., Ph.D.

CANCER (THERAPY)

Complete Destruction of a Humerus by Osteoclastic Carcinomatous Metastases. R. Finsterbusch and G. Schumann. *Röntgenpraxis* May 1937 9, 319-323.

The course of an extensive destruction of a metastasis from a primary cancer of the breast to a humerus is shown. The humerus was completely destroyed and no evidence of bone structure could be seen on roentgenograms. There occurred a marked shortening of the soft tissues of the arm. X-ray therapy achieved a worthwhile palliation.

HANS W. HEFKE, M.D.

DOSAGE

Present Status of the Definition and the Measurement of the Dose. H. Holthusen. *Strahlentherapie* 1937 59, 503.

This is the text of an address given by Holthusen in memory of Albers-Schönberg. He reviews briefly the present status of dosimetry touching the problems of back scatter, direct and indirect determination of the applied dose, and the relation between the measured dose and effect in the tissue.

ERNST A. POHLE, M.D., Ph.D.

Distribution of Roentgen ray Intensity during Irradiation with Convergent Beams. M. Nakaidzumi and N. Motida. *Strahlentherapie* 1937 60, 307.

The authors used a small ionization chamber for the determination of the intensity distribution of roentgen rays in a wax phantom when using multiple convergent beams. The isodose curves have an entirely different shape under these conditions as compared with the standard curves available for single fields. The depth dose with convergent beams is much higher—up to 6 cm. below the surface—as compared with the single-field method. The periodical distribution of the dose during a single irradiation with convergent fields varies with the depth dose and with the distance from the central axis.

ERNST A. POHLE, M.D., Ph.D.

The Absorption and Scattering of Monochromatic Roentgen Rays in Water, Triolein, Blood, Skeletal

Muscle, and Subcutaneous Tissue of Man. H. Tribes. *Strahlentherapie* 1937 60, 330.

The author determined the mass absorption coefficients of the various media named, using monochromatic roentgen rays between 0.128 and 1.433 Å produced by means of the "filter difference" method developed by Küstner. Muscle tissue absorbs for all wave lengths the same as water, longer wave lengths are absorbed more in blood and somewhat less in subcutaneous tissue with a higher water content than water. Triolein (an oil) and subcutaneous tissue with low water content absorbed less than water and approached the same values as human fat. For radiation of short wave length the mass absorption coefficients of all examined materials are nearly equal. For practical purposes one must realize, therefore, that depth doses obtained in a water phantom hold for subcutaneous tissue with a high water content if superficial radiation therapy is given. For subcutaneous tissue with a low water content the depth dose in 6 cm. may be 80 per cent higher than the one determined in the water phantom. For deep therapy using roentgen rays of short wave length the water phantom is well suited for determining isodose curves.

ERNST A. POHLE, M.D., Ph.D.

EPILEPSY

Some Factors in the Pathogenesis of Genuine Epilepsy as Determined Radiologically. Eugenio Fischel. *Archivio di Radiologia* September-December 1936 15, 329-335.

Fischel points out that in epilepsy there is usually an enlargement of the sella, and as a result of this there is an upset in the endocrinal balance of the pituitary, causing epilepsy by a transitory ischemia. The underlying lesion is probably an inflammatory one.

E. T. LEDDA, M.D.

FLUOROSCOPY

Testing the Ability to See in the Dark. Chantaine and Cramer. *Röntgenpraxis* May, 1937 9, 329-336.

There is still some dispute about the comparative value of fluoroscopy and films of the chest. It may be possible that some roentgenologists have a peculiarly acute vision in the darkroom, which may be very poor in others. The authors attempted to test 30 physicians and 20 patients for their ability to see in the darkroom. They did it by using roentgenograms of lead numbers of different contrast; the lead numbers were exposed to 10, 12, 14, etc. per cent up to 20 per cent of the routine exposure. The films showing these differently exposed numbers were then read in front of the fluoroscopic screen under the normal conditions of fluoroscopy. The person to be examined was asked to read the numbers after two, five, and ten minutes of adaptation to the dark. Three different grades of visual accuracy were arranged: good, medium, and

18 months' duration gave antecedent histories of indigestion

Vomiting was recorded in six histories one patient in whom it had been present for two months before the diagnosis was made, gave it as the symptom of onset. At necropsy the cancer was at the lower end of the esophagus and extended into the stomach. The tumor in four of these patients was in the middle third and in two in the lower third.

Hematemesis occurred in three cases, though not as the initial symptom, but in one patient, a male, 73 years of age, with a fungating growth at the lower end of the esophagus, the symptom of onset was sudden severe pain in the abdomen followed by gastric hemorrhage. In the other patients the tumors were in the middle third.

Hoarseness was complained of by six patients. In two, it was the symptom of onset, in one patient had been present for less than two months, and in another for less than three. In this second patient there was an associated paralysis of the left vocal cord. In two patients the lesion was located high in the esophagus, in two it was in the middle third, and in two in the lower.

Cough was the symptom of onset in one case. It occurred with pain in the throat on swallowing in a male, 57 years of age, who had a squamous-cell carcinoma of the middle third with obstruction high in the esophagus. There were no other instances of cough as a symptom.

Swelling of the neck as the initial symptom was complained of by one patient, the only case in which it occurred. The patient was a female, 55 years of age, who had the swelling for six months. She had a squamous-cell carcinoma involving the middle third and extending upward almost to the pharynx.

Duration of Symptoms—In 87 patients the interval from the first symptom to the time the diagnosis was made was less than a year. It was less than six months in 58, and between six months and a year

in 29. In only 13 was it present for more than a year.

Roentgenologic Characteristics—The roentgenologic characteristics of far advanced carcinoma of the esophagus are generally known and no attempt has been made to tabulate the findings. The alterations of contour in the opaque stream used to examine the esophagus correspond to the alterations in the lumen of the organ produced by the tumor. These alterations are usually irregular, and involve one or more sides of the tube when the growth extends in a cephalo-caudal direction, or constrict its entire circumference when it is annular. The irregularities of contour are always associated with narrowing of the lumen at the site of the tumor, and usually, with dilatation of the esophagus proximal to it. Sometimes the constriction is smooth and difficult to differentiate from stricture due to the swallowing of a caustic, when smooth and at the hiatus, differentiation from functional spasm may be impossible.

There was positive roentgenologic evidence of organic disease thought to be due to neoplasm in 95 patients, indicating that in this series, as in most, the disease was far advanced when the patients first presented themselves for examination. In the others there was found evidence of alteration, but the diagnosis was not properly made as to the etiology. One patient with cancer was diagnosed as having a caustic stricture, another as having a phrenospasm.

The opposite error is sometimes made that is, some other lesion is mistaken for carcinoma. These mistakes are not so disastrous. The most common errors are made in mistaking caustic strictures and phrenospasm for neoplasms, and occasionally diverticula and varices are improperly labeled newgrowth. In some instances constriction of the lumen by extra-esophageal masses may lead to an appearance simulating an intrinsic growth.

Phases of the roentgenology of carcinoma of the esophagus worthy of special comment are the difficulty in determining in cases at the hiatus whether the tumor is

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THE BEDSIDE MANNER IN RADIOLOGY¹

By BENJAMIN H. ORNDOFF, M.D., F.A.C.R., Chicago

INTRODUCTION

IN discussing the bedside manner in radiology, I am impressed with a quotation from Hippocrates, "To serve the art of medicine as it should be served, one must love his fellowman." Byron Robinson said, "Adequate information concerning a disease can be obtained only at the bedside." Again, I quote from Alfred Stengel, "In the rapid development of the more rigidly scientific methods of diagnosis emanating from the laboratory, a feeling of disregard if not contempt for the other clinical methods has too often made its appearance, not rarely perhaps on account of a greater familiarity with many of the newer methods of investigation." A discussion of the bedside manner in radiology presupposes that the practice of radiology is accepted as the practice of medicine. It must follow then that radiology becomes a special branch or division of medicine.

Radiology, as a branch of medicine, has undergone the evolutionary processes pointed out so clearly by Thomas A. Groover and is now becoming stabilized as a specialty in medicine. The integration of radiological practice into the general practice of medicine as it exists in the United States to-day becomes a problem

of prime importance. The scientific phases of radiology are already deeply rooted in the science of medicine, and it becomes our duty to organize ourselves for the proper application of radiology in the future. We must develop a strong and dignified group, carefully, but not over-organized, in order that radiology as a specialty may be equally attractive among the branches of medicine.

The preservation of a specialty in its proper form may become a more difficult undertaking than its creation. It seems quite evident that our scientific organizations, local, national, and international, with their essential purposes concerned with the presentation and dissemination of scientific data, have performed their duty most commendably. Problems arising in the practice of radiology may seem to have lagged, but this is only a matter of sequence in evolution. Through the American College of Radiology and its Commissions, many important movements have been initiated and activities are now in progress which promise much for future practice in this specialty.

PRACTICE

The practice of radiology, like other divisions of medicine, is deeply concerned with diagnosis as well as treatment. The diagnostic phase of radiology is indeed very broad and comprehensive. Diagnosis is not merely pinning a label on a disease, nor

¹ Presented at the Eighth Annual Conference and Conference of Teachers of Clinical Radiology under the auspices of the Commission on Education, American College of Radiology, Chicago, Feb. 13, 1938.

the same when the cancer was in the middle and lower thirds, and lower only when it occurred in the upper. Vomiting occurred only with growths in the lower and middle thirds.

While hoarseness, hematemesis, and cough are not common symptoms in carcinoma of the esophagus, the possibility that esophageal malignancy may be responsible for them should be borne in mind, and esophageal cancer excluded when there is nothing else to account for these symptoms.

Patients with carcinoma of the esophagus do not seem to come under roentgen observation until the disease is far advanced, for in 95 per cent the diagnosis of organic disease was made and malignancy suspected at the time of the first roentgen study. If roentgen signs leading to early diagnosis permitting of radical surgical procedures are to be discovered, patients will have to come under observation earlier in the course of the disease than they do at present.

medical management With the private patient, the radiologist is obviously conscious that he is the patient's doctor The radiologist with the referred clientele is, by the nature of things, in a somewhat different position and may become inclined to drift in the direction of the true scientist, who may discover a disease and direct its healing May I urge that, without regard to the class of practice we undertake in radiology, we do not become disease detectors and curers, but above everything we remain physicians in our attitude toward the patient In this connection something can also be said with regard to the attitude of the patient It is obvious that already the public conception of the radiologist is not indicated in the question, "What disease have I and will you cure it?" but rather it is indicated in the question, "Doctor, will you endeavor to determine why I am not well, and assist me in restoring and keeping my health?"

The principles of medical ethics, observed by the radiologist, should correspond to those in other divisions of the practice of medicine If the radiologist is in private practice, the major portion of his work will be in his management of the clientele, referring such cases as become necessary to other specialties, and correlating all of the required data for proper care If the radiologist has a consulting practice in connection with the medical staff of hospitals, clinics, and other institutions, his study of the patients and his relationship with them varies considerably, inasmuch as it is more indirect—through the referring physician

For the benefit of the future of this specialty, there should be a strong group within it who practise the bedside manner in radiology There is a public demand for this character of medical service It would not interfere with the radiologist in group practice Considering these two types of radiological practice, there arises again the question of the individual relation between the patient and the physician It seems almost certain that the radiologist in group practice must sacrifice individual-

ism, but he should preserve his personality with the patient

The reaction of patients who have received radiological service in different medical groups convinces me that the radiologist performs a greater service to the public and to the profession when he maintains a proper personal relationship with the patient It seems wholesome, indeed, when patients speak the name of the radiologist who was connected with the clinic or institution where they received medical service They frequently express appreciation and praise for courteous and kindly service, while in connection with other institutions of equal professional standing they do not hesitate to state that they never met the radiologist in charge and that their service through the technicians became more one of machine-shop variety Only recently I became quite interested in the description by a patient who seemed anxious to relate her experiences in a radiological department of a large medical institution She described her approach to the department, which was appropriately decorated, the general atmosphere quite acceptable in spite of the great amount of equipment which appeared well kept and in good order, and one of the many examining rooms which might ordinarily be depressing became pleasant because the technical worker appeared so friendly while preparing the equipment for the examination, and a few moments later this same technician introduced the radiologist who was head of the department He inquired briefly but sufficiently into the cardinal symptoms, correlating them with the order from the floor, which indicated the information desired by her doctor, and then very quickly gave the proper orders to the technical workers for the examination The patient was fully convinced that all of the work of the department was being directed by a physician and expressed gratitude for her doctor's recommendations

If we feel degraded by being designated as "the x-ray men" for the hospital, the clinic, or the group, we must not approach

58 per cent and less than a year in 87 per cent. This short duration indicates that esophageal tumors are rapid growing.

As would be expected, mechanical interference with swallowing leads to dysphagia, the most frequently encountered initial symptom and the one with the highest incidence. The rapidity of its development and the pain which commonly accompanies it are the only features making it at all unlike dysphagia in other conditions. Seventy-three patients complained of pain of some degree during or after swallowing. Pain is not an accompaniment of dysphagia in phrenospasm, diverticulosis, or esophageal varices.

Other symptoms sometimes associated with obstruction of the esophagus make it important that the esophagus be studied when they occur. Regurgitation and vomiting belong in this category. Regurgitation has no apparent relationship to the site of the tumor, the percentages of the sites, and the percentages of the sites in relation to regurgitation being practically

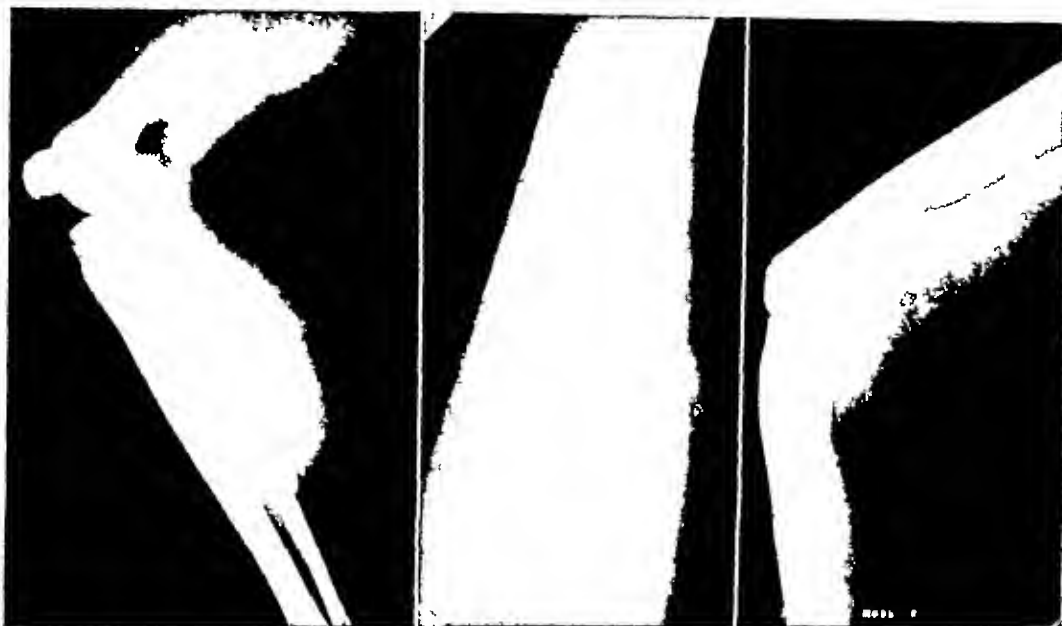
questing payment for your services. This situation is aptly depicted in the old cartoon in which the doctor appears in three aspects. First, as a blessed angel when he calls at the bedside of the sick patient, second, as a veritable god when the cure has been perfected and the patient returns to his feet, and third, as the very devil when he presents his bill. Whatever we may draw from this, it becomes evident that the patient's reactions are occasionally somewhat violent in character and demonstrate the emotional rather than the rational responses.

COMMENTS

In these times when our living conditions are changing so rapidly, and when one scientific achievement follows so closely upon another, radical moves along all lines are more likely to occur. Human relationships are being examined in all of their phases and many are in a state of readjustment at this moment. Before us are problems, individual and collective in character, which threaten to change the general order of almost every pursuit in life, the education of the medical student and the practice of medicine offer no

exceptions. It becomes our duty in this organization of teachers of radiology to avoid, so far as it is humanly possible, the sowing of the seed of over-socialization or the creation of state medicine.

In closing, let me reiterate that the essential quality of a physician is interest in humanity. In the bedside manner for radiological practice, time, sympathy, and understanding must be lavishly dispensed. The reward will be found in that personal bond which forms the greatest satisfaction to the physician in the practice of medicine. Responsibility should be something tangible. It seems best if it be individual, but for the radiologist in group practice, I admonish you to preserve your personality. The most ideal relationship between patient and physician is one of mutual trust. Where there is a deep spirit of trust, there follows no suspicion nor misunderstanding. When these conditions prevail, the period of illness becomes, as it were, a return to childhood's dependency. The patient experiences a freedom from responsibility, a resignation to the care of his physician, the nurse, and the hospital, and recovery is thereby speeded, if it is at all possible.



No 1 Soft tissue radiograph of muscles of the calf, showing a moderate degree of atrophy. This is indicated by the increase in width and decrease in density of the intervesicular spaces in the muscles. This gives rise to a rather marked striated appearance. Sometimes this is noted before there is an actual demonstrable decrease in size of the muscle.

No 2 A racemose non-encapsulated hemangioma of the soft tissues over the right shin. Note the worm-like vascular structures. This is characteristic of hemangioma.

No 3 Radiograph of normal brachial vessels. Soft tissue radiography is ideal for demonstrating early calcific changes, particularly in the small arteries.

than 2.5 kv p larger steps will result in too marked variation, especially when dealing with the smaller parts. The current source should preferably not come from a transformer which has a heavy fluctuating demand from some other source.

The x-ray tube requirements for soft tissue radiography are in general similar to those of other types of work, *viz*, as small a focal spot as is consistent with the permissible energy load of the tube. In this connection it should be remembered that inasmuch as the kilovoltage is low a larger milampere-second ratio can be tolerated without exceeding the energy limits. The target should be in the best condition, as a pitted target tends to reduce detail. While probably better results can be obtained without the use of a filter, the small amount of filtration inherent in the oil of a shock-proof apparatus is negligible from a practical standpoint. In the range of lower than 30 kilovolts the

absorption of the radiation by the glass wall of the tube probably plays a significant part.

The X-ray Film—The ideal characteristics of emulsion for soft tissue work are as follows:

(1) There should be considerable latitude to compensate for variations in exposure caused by miscalculations or fluctuations of the line.

(2) *Maximum contrast* There should be a maximum differential between the blackest blacks and the whitest whites.

(3) *A long gradation scale* That is, the maximum contrast should hold throughout the entire gradation scale. We have coined the word "diatrast" for this attribute.

(4) *The speed of emulsion* While an increase in speed of the emulsion is desirable, nevertheless it is not of major importance.

(5) *Keeping qualities, particularly freedom from inherent fog* This is a matter of

TABLE II — CARCINOMA OF ESOPHAGUS

	Symptoms Incidence	As Initial Symptom
Dysphagia	96	71
Pain	73	11
Loss of weight	81	2
Loss of strength	13	
Regurgitation	65	3
Belching	11	1
Indigestion	7	7
Vomiting	6	1
Hematemesis	3	
Hoarseness	6	2
Cough	1	1
Swelling of neck	1	1

TABLE III — CARCINOMA OF ESOPHAGUS

Duration of Symptoms		
Less than one month	2	
1-2 Months	11	58 { Less than six months
2-3 "	18	
3-4 "	11	
4-5 "	11	
5-6 "	5	
6-7 "	13	29 { Six months to one year
7-8 "	6	
8-9 "	2	
9-10 "	5	
10-11 "	2	
11-12 "	1	12 { More than one year
12-18 "	8	
18 Plus	4	
Unknown	1	

53.5 per cent) had difficulty in swallowing for less than six months before coming under observation, and 23 (or 30.9 per cent) had it only from six months to a year. In only two patients was the dysphagia present for more than 18 months.

Pain was the second most frequently encountered symptom of onset. Of the 73 cases in which it occurred, it was the first symptom in 11. In six histories it was recorded that there was no pain. It was variously described as soreness, distress, or intense pain. The most common site was the midline of the thorax, though in some patients it was located in the epigastrium; sometimes it radiated to the back. In most patients it came on after eating, though in some it was constant and bore no relation to the taking of food. As the symptom of onset it was present for less than six months in seven instances and from six months to a year in two cases.

Loss of weight was present in 81 cases, absent in five, and was not mentioned in

14 histories. Two patients listed it as the first symptom. In one, a male, 62 years of age, the loss had been gradual and amounted to 20 pounds (9 kg) in eight months, the only other symptom of which he complained was dysphagia. The second patient was a male, 60 years of age; he complained also of dysphagia, belching, and regurgitation. In 49 patients the amount lost was recorded; it averaged 25.7 pounds (11.6 kg) per patient. The greatest loss took place in a male, 46 years of age, he lost 130 pounds (59 kg) in 11 months. In 13 patients weakness accompanied the loss of weight.

Regurgitation was complained of by 65 patients, 12 patients had none, and in 23 histories it was not mentioned. It occurred three times as the primary symptom, in one patient it had been present for three months, in two patients for four months. In 25 patients who complained of regurgitation the lesion was in the lower third, in 21 in the middle third, and in nine in the upper third.

Belching was recorded in 11 instances, in one patient it was the first symptom and had been present from seven to eight months before the patient came under observation. The growths in these patients were in the lower third in five cases, in the middle third in two, in the upper third in two, and in two the location was not determined.

'Indigestion' was the chief complaint of seven patients, in all of whom it was the symptom of onset. The term really indicated a number of symptoms referable to the gastro-intestinal tract, no one of which was so marked as to deserve particular comment at the time of onset. These patients complained of general malaise, frequently with heartburn, belching, or regurgitation. Dysphagia was not a marked symptom. Patients who gave indigestion as the initial symptom also had the longest interval between onset of the symptom and final diagnosis. One patient had recurring attacks of indigestion for many years. Two patients in whom the first symptom was dysphagia of more than

THE IMMEDIATE AND END-RESULTS OF RADIATION THERAPY IN CERTAIN BENIGN BONE TUMORS¹

By HOWARD P DOUB, M D, FRANK W HARTMAN, M D, and
C LESLIE MITCHELL, M D, *Detroit, Michigan*

From the Departments of Roentgenology, Pathology, and Orthopedic Surgery,
Henry Ford Hospital

THE widespread application of radiation therapy in certain benign bone tumors, notably giant-cell tumors, has made it seem worthwhile to review the results of this type of therapy, and to compare them with the results of surgery. An increasing number of reported results are accumulating each year so that some estimate as to the relative value of radiation therapy in this field should be possible.

The traditional surgical treatment has been amputation, resection, or curettage, with or without cauterization. The results obtained by the use of these methods are well known.

The experience of various observers, particularly Bloodgood, has been such that the name *giant-cell sarcoma* has been replaced in this country by the name *benign giant-cell tumor*. In spite of this, there are an increasing number of so-called giant-cell variants being reported. Other cases are being reported in which malignancy supervened following some form of trauma. Some of these cases had undergone radiation therapy. A discussion of this aspect of the subject will be given. Several cases of malignant variation will be reported.

We will first consider the problem of the benign giant-cell tumor. This tumor is found in youth, and through the middle decades of life, but is more common in the third decade. It occurs most frequently in the distal ends of the diaphyses of the femur and radius, and the proximal end of the tibia. It may occur, however, in the diaphyseal ends of any of the long bones, the mandible, or flat bones. Many authors state that these tumors involve the epiphyses of the bones, but as Peirce (19) points out, this terminology is incorrect.

It occurs in the metaphysis and does not cross the epiphyseal line until this cartilage line has disappeared and has become ossified. It may break through the capsule and invade the soft tissues, but rarely extends into the joint cavity.

On the roentgenogram, this tumor is revealed as a cyst-like osteolytic tumor in the ends of the diaphyses. It is often eccentrically placed, expanding and thinning the cortex on one side and extending medially at the expense of cancellous bone. When centrally placed, it expands the cortex equally on either side. The cortex has a thin bony outline which is frequently perforated, and which when intact, has every appearance of fragility. There is an absence of periosteal elevation or reaction such as is present in osteogenic sarcoma. Evidence of invasion is not seen. Bony trabeculae are often present, producing a picture similar to that of a multilocular cyst. The radiographic signs are characteristic, and a definite diagnosis can usually be made by this examination alone.

The gross appearance of the tumor is that of a friable or jelly-like substance, which varies in color from red to gray or black. Bloody fluid is often found in these tumors, and excessive hemorrhage is one of the contra-indications to biopsy, according to some authors. The cortex is thin and is composed of new bone laid down by the periosteum as it is pushed outward by the growing tumor.

Histologically, the tumor shows large multinucleated giant cells, either scattered or in clumps. These cells contain multiple nuclei and may inclose blood cells, detritus, bone granules, or lipid material. The supporting structure contains fine capillaries with both spindle cells and round cells. In the typical giant-cell tumor the

¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

primary in the esophagus or involves it secondarily by extension from the stomach, the relation of foreign body lodgment to the condition, the pulmonary and pleural complications due to fistulæ with the formation of abscess or empyema, the development of suppurative foci in the lungs without fistula formation, pulmonary and vertebral metastasis

While often the determination as to whether the carcinoma arose in the esophagus or was involved secondarily by extension from the stomach is academic, in some instances it is important to determine if there is gastric involvement. This is particularly true when the question of resection of the esophagus or stomach arises. When the stomach and esophagus are involved in the same growth the tumor is usually located along the anterior and lesser curvature sides of the stomach.

In occasional instances, the lodgment of a bolus of food at the site of the growth, with sudden and complete obstruction of the esophagus, may be the first sign of neoplasm. It is important, therefore, that the esophagus be re-examined after the removal of the lodged bolus, to exclude the possibility of malignancy.

Sometimes a fistula develops between the esophagus and a bronchus, due to erosion of the esophagus by the growth, or a sinus may develop between the esophagus and the pleural cavity. When a fistula forms between the esophagus and the air passages a pulmonary abscess may develop. Abscesses of this type present the usual roentgen characteristics with cavity and fluid level. Empyema secondary to invasion of the pleura by the growth is usually complicated by the development of a pyopneumothorax from the air which gains entrance to the pleural cavity during the act of swallowing.

When the tumor develops in the upper third of the structure it may cause a spillover of material into the larynx and trachea. In these cases there may develop multiple suppurative pulmonary foci instead of a single abscess. The foci are

more commonly seen in the dependent portion of the lungs, in the lower lobes.

Metastasis to the lungs presents the same appearance that metastasis from other tumors shows. When metastasis occurs in the vertebræ, it is usually of the osteoclastic type attended by varying degrees of destruction of the involved vertebræ.

COMMENT

Analysis of the clinical and roentgenologic findings does little to bring about the end for which the study was undertaken, namely, the unearthing of signs and symptoms by which diagnosis of cancer of the esophagus can be made earlier. However, certain facts have been emphasized and are worthy of note.

Cancer of the esophagus occurs three times more frequently in the lower third and in the middle third than it does in the upper. It is twelve times more frequent in male than in female patients. Age at the time of onset is higher than in cancer in some locations, 86 per cent of the patients being over 50 years of age.

Familial malignancy seems to play no rôle. In 91 per cent there was no history of malignancy, and cancer of the esophagus was not recorded in a single instance. While it appears that heredity plays a negligible part, it should be borne in mind that the records were only those of the immediate family, the collateral lines not being included.

The influence of syphilis is of no apparent import, for in cases in which the blood was studied the ratio of the negative to positive reactions was as 13 to 1.

If any progress is to be made in early diagnosis, it will have to come by making patients conscious of the importance of early symptoms. In this series of cases, as in most series, the majority of the patients must have been suffering from advanced malignancy at the time they first came under observation, for the symptoms were of relatively short duration. Symptoms were present less than six months in

Radiotherapy cured 75 per cent of the cases in which it alone was used. Coley's serum cleared up 42 per cent in a series of seven cases.

Pfahler and Parry (22), in a report of 26 cases, state that all obtained good results from radiotherapy. One of these cases was probably the first recorded case of giant-cell tumor treated by radiotherapy. These authors gave no detailed discussion of their cases.

In a recent report by Peirce and Lampe (21), a total of 83.2 per cent of their patients, treated by radiotherapy alone, obtained a satisfactory result, while in those cases in which it was used post-operatively a total of 85 per cent were well. In a small group who had both pre-operative and post-operative radiotherapy the result was satisfactory in only 40 per cent of the cases. Geschickter and Copeland (9), in their recent publication, report ten cases that have received radiotherapy. Five had had satisfactory results, and in five surgery was used later. It is not stated who treated these cases or what radiotherapeutic technique was used.

We have recently made a study of 22 cases of benign giant-cell tumors from the Bone Tumor Registry, which had sections showing the histology of the original tumor and a satisfactory follow-up later. There were nine cases treated by radiation only, in which the patient remained well. Four cases were well after receiving both curettage and radiation therapy, while in five cases radiation therapy was applied and resection or amputation was performed later. The patients are all well. One malignant variant was treated by amputation and the patient was well four years later. In three cases of benign giant-cell tumor which received radiation therapy the lesions later became malignant. One showed typical fibrosarcoma and two osteogenic sarcoma, one received roentgen therapy only, while two received curettage in addition to roentgen and radium therapy. In two other cases, which had only an original x-ray diagnosis of giant-cell tumor and no confirmatory sections, the

lesions later showed definite evidence of malignant transformation. These two cases received roentgen therapy only, we do not include these as proved cases.

In only four of our cases of giant-cell tumor which were treated by means of radiotherapy do we have a satisfactory follow-up to determine the end-results and present condition. In one case the patient is free of the tumor but sustained a telescoping of the lower end of the femur, probably due to over-irradiation. In a second case the result is satisfactory. In a third case, to be presented here, malignancy developed during the course of treatment and amputation was done. The patient is well at this time although metastatic glands were found in the groin after amputation. In the fourth case, malignancy was present at the time of admission. X-ray therapy controlled this tumor for more than a year, but because of enlargement of the growth intra-abdominally, the patient decided to try serum therapy. Death occurred several months later.

MALIGNANT VARIATION

The argument as to whether giant-cell tumors ever undergo malignant transformation has been a long one. Nelaton is said to have been one of the earliest advocates of the opinion that they are always benign and never metastasize. Coley (3) quotes Virchow at length as believing that giant-cell tumors not only recur, but may prove to be malignant in some cases.

In 1930, Geschickter and Copeland (8) studied all the cases of the metastatic group of giant-cell tumors, from the literature and from the records of the surgical-pathological laboratory of the Johns Hopkins Hospital. They studied eight cases and came to two important conclusions: (1) Whenever metastases were found, they showed the histology of osteogenic sarcoma, and not of the original giant-cell tumor, (2) in no one case of an originally benign and typical giant-cell tumor have they found a secondary metastatic osteogenic sarcoma in the lung. In four of the cases, diagnostic errors were made, either

SOME IMPORTANT CONSIDERATIONS IN THE ROENTGENOGRAPHIC DEMONSTRATION OF TISSUES, NORMAL AND PATHOLOGICAL, HAVING A RELATIVELY LOW DIFFERENTIAL ABSORPTION¹

By JOHN RUSSELL CARTY, M D, *New York City*

THE radiographic demonstration of tissues having low differential absorption presents certain difficulties which should be thoroughly understood if consistent results are to be expected. Successful soft tissue radiography aims to demonstrate these structures with the same detail as that obtained with the conventional radiograph of the osseous structure. Mere outlines do not constitute an adequate examination.

A consideration of the soft parts will soon convince one of the great complexity of the structures and the slight differential absorption of contiguous structures. We may consider these tissues as consisting roughly of concentric layers of tissue, the outer ones being completely circumferential, enclosing in turn smaller layers consisting of bundles of muscles, vessels, and nerves. Between these layers and within there are innumerable potential fascial spaces, sometimes containing a small amount of fat. It is these spaces which give the necessary variation in density, be it ever so slight, to record the detail on the radiograph. They extend between the muscle bundles of a single muscle as well as enclosing vessels and nerves. They are distensible by air, having a remarkable intercommunication.

Briefly stated, the problem becomes one of obtaining the maximum contrast throughout the entire scale of density and consistently duplicating results. Up to a certain point the gradation scale contrast is dependent on the wave length, other factors remaining the same. Thus, best results are obtained with "soft" or low voltage radiation, provided adequate penetration of the part being studied is secured. Under-penetration obliterates detail even

more completely than over-penetration. As is the case with conventional osseous radiography, there is an optimum kilovoltage where the best results are obtained. There is a common feeling that a "soft" effect can be obtained by merely under-developing. Correct exposure and development are essential. If one changes the effective beam by increasing the voltage or increasing filtration, or both, the "snap" or "sparkle" of the radiograph is gradually lost and the differential detail tends to flatten out. In a series of comparative tests we were able to show that full wave rectification gave superior results as compared with half wave on the same part. The character of the beam of radiation obtained by various types of radiographic machines is dependent on various factors, most of which are well understood.

The factor played by the milliamperesecond ratio is definite but less understandable. It has been our experience that under most conditions 300 ma-sec is the optimum. An exception may be noted in the case of some small self-rectified portable units by means of which soft tissue radiography of small parts may be satisfactorily made with a smaller ratio.

The element of motion does not play so important a rôle in extremity work as elsewhere. The limb can be immobilized by sand bags and the movements caused by pulsation of arteries do not seem to cause trouble.

In cases in which there is such a small permissible variation in technique it becomes obvious that all sources of current fluctuation must be eliminated and that regulation of the machine must be fine and accurate. Thus the supply line should be of ample size. Autotransformer control is far superior and should have steps of not less

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patient improved clinically, but was traced only seven months. In the first case the probable sequence of events was a primary giant-cell tumor of the rib, which was later converted into an osteogenic sarcoma. Injury may have been the inciting factor. The x-ray therapy did not enter into this part of the picture. The second case is not clear-cut, but probably is one of development of malignancy in a pre-existing giant-cell tumor, coming on after an old injury.

Coley (3), in 1935, discussed malignant changes occurring in giant-cell tumors and strongly charged that primary benign giant-cell tumors do change in character to malignant metastasizing tumors. He estimated that about 15 per cent of tumors, diagnosed as benign giant-cell tumors by experienced pathologists, later become malignant. He reported 19 cases, in which he presented various forms of evidence of an original diagnosis of giant-cell tumor. These all subsequently developed malignancy.

In attempting to determine a possible cause for the development of malignancy in a previously benign tumor, one must consider the various factors which may be involved. Many have tried to predict the development of malignancy from the cell type in the original benign tumor. Simmons (25) came to the conclusion that the cell type was of little clinical importance. He states that the appearance of the tumor varies according to the age of the tumor, previous treatment, and trauma. In 19 of the cases he studied, some question arose in the minds of the examiners as to presence of malignancy at the time of the first biopsy. The results in these cases, however, were the same as those in which no doubt arose. Geschickter and Copeland (8) state that in a few instances unsuccessful treatment or trauma, to a benign tumor, may by its failure to heal, provide a fertile field for the subsequent development of osteogenic sarcoma. The nature of the original lesion is not the important factor.

Stone and Ewing (27) in their report state that the malignant transformation in

their case came as a result of various insults in which curettage and imperfect irradiation probably played the leading part. They advise against the insertion of radium into the tumor cavity and are in favor of the use of external irradiation. Coley (3) states that the patient with an apparently cured giant-cell tumor should be cautioned to avoid any local trauma.

Some authors have attempted to prove that radiation therapy may be the inciting cause in the development of osteogenic sarcoma in a previously benign giant-cell tumor. Coley (3) reported 19 cases of giant-cell tumors that were supposed to have become malignant. Most of these cases, at one time or another, had had radiation therapy. He, therefore, came to the conclusion that radiation therapy may have had some influence in producing the malignancy. A critical study of his cases would seem to indicate that 11 of them had had an undiagnosed malignancy when first seen and before any therapeutic measures were instituted.

Becker (1) collected 15 cases from the literature in which sarcoma developed subsequent to irradiation of tuberculous knees. The diagnosis of tuberculosis was made histologically in only two cases, the spindle-cell sarcoma developing from three to twelve years after the application of the roentgen therapy. From the lack of exact details of the cases in this report, it is difficult to determine what rôle radiation therapy may have played in the occurrence of the malignancy.

Martland (17) studied the occurrence of osteogenic sarcoma in radio-active watch dial painters. In 18 deaths among these people, five of them were caused by osteogenic sarcoma. Among 30 living dial painters who were radio-active, four had osteogenic sarcoma. In these cases the sarcoma always started in some area that was previously the site of radiation osteitis, the osteitis being of the osteoporotic type in contradistinction to the productive or sclerotic osteitis described by Ewing (7) and Phemister (23) following the external type of irradiation. Martland believes

considerable importance as the presence of fog is exceedingly detrimental to the fine detail in soft tissue radiography

(6) *Uniformity* This is a matter of great importance as it permits the standardization of a rather exacting technic

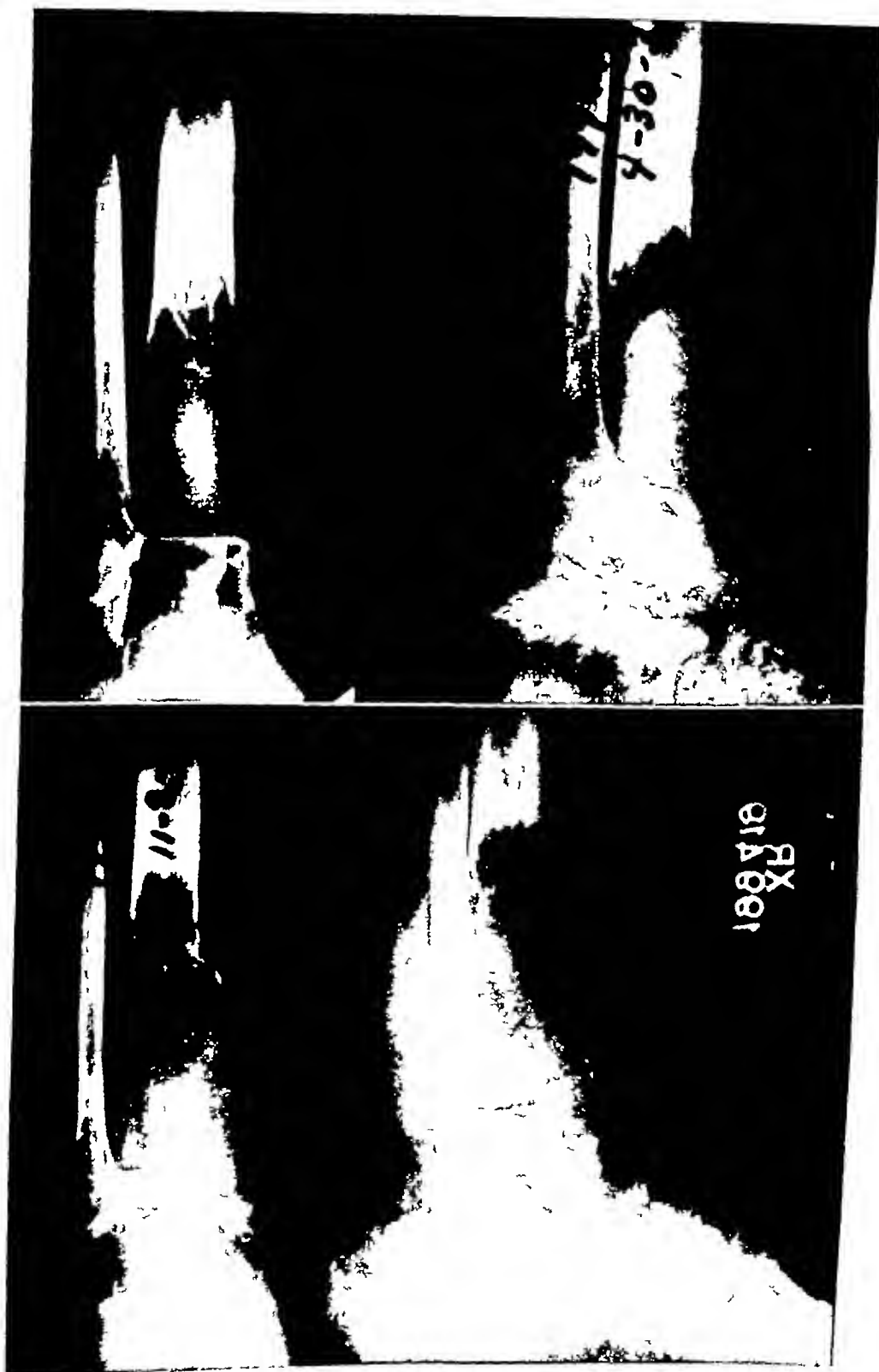
Intensifying screens are used, single screens preferably, but a double screen gives excellent results. Screen speed should not be too fast as graininess may result, which has some effect on the detail. Needless to say, the screens should be kept clean and the cassettes should always be in good contact. The intensifying screen should not be kept too long, as age apparently has an effect on the resulting radiograph.

Development is very important and is done by "sight." A routine time-and-temperature development is not suited to this work. The film is inspected during development as infrequently as possible, and when the part it is desired to demonstrate becomes visible, the film is removed from the developer. As we remarked earlier, there is an optimum exposure which is critical as compared with conventional radiography and which can be corrected only to a small extent during development. Too dim a safe light makes visible developing difficult. The solutions must be fresh and at the proper temperature. Fog from any cause must be avoided. Pincryptol green may be used for desensitization in order that the films can be developed by weak white light without fogging. While this has the advantage of permitting more critical development, the results are hardly worth

the extra procedure necessitated by desensitization. The film should be thoroughly washed, dried fairly rapidly in a dust-free, warm column of air.

The finished radiograph should be illuminated by lights of various wave lengths and intensity. It is surprising to see how certain soft tissue shadows can be made apparent by changing the intensity or quality of the illumination. No study of a soft tissue radiograph is complete without varying the illumination.

It is a matter of vital importance to have some medical member of the x-ray department responsible for all radiographic examinations involving soft tissues. If this is not the case, the technic is apt to fail, particularly at the start, as it requires constant supervision by some one having medical knowledge and interest in this work. At the New York Hospital the soft tissue radiographs are developed by "sight," usually by the technician who made the exposure, in a small separate dark room. If the development is attempted in the large main dark room, the routine work is apt to be held up or else the soft tissue radiographs rushed through without adequate attention. Carelessness or hurry is fatal to good results. The very fact that consistently good soft tissue radiography can be done in a large department is an indication in itself of good organization. After a period of time during which the technicians become familiar with the work, the supervision necessary may be considerably reduced and still the quality of work may be maintained.



(See legends on opposite page)

round cells predominate. Hemorrhagic areas are often present throughout the tumor. Newly formed bone may be seen in the capsule, and occasionally parts of the old bone undergoing destruction.

Radiation therapy in giant-cell tumors of bone was popularized by the report by Herendeen (10) in 1924, of the results obtained in a series of 16 cases treated by irradiation only. At that time the dosage recommended was sufficient to produce a skin erythema and a considerable reaction in the tumor. This was manifested by rapid enlargement of the tumor with expansion of the cortex and thinning and decalcification of the bony shell until it was barely visible. The soft parts were swollen and edematous to the touch. This gave the appearance of rapid increase in growth of the tumor at this stage. After some weeks or months the swelling subsided, the tumor became firm to the touch, and the roentgenograms disclosed recalcification in the tumor outline.

In a later report Herendeen (11) reported a marked reduction in the radiation dosage. He stated that bone regeneration followed more promptly and complications were less common with lighter dosage. He stated that if light dosage does not give the desired result, the lesion is probably not a benign giant-cell tumor.

Among the many later reports on this subject are excellent contributions by Peirce (19, 20, 21), Lacharité (14), Evans and Leucutia (6), Pfahler and Parry (22), Soeur (26), and others. The general tendency in dosage has been downward until at the present time a destructive reaction is avoided. Most reports indicate a gradual reduction in the dosage in succeeding treatments.

Our practice has been to use 185 to 200 kv with 0.5 mm copper plus 1 mm aluminum filtration at 50 cm target-skin distance. Our dosage varies from 400 to 500 r units applied through each of two or more portals of entry. A full dose over each port is usually applied at one sitting. The progress is watched by means of periodical roentgenograms and clinical observations.

Succeeding treatments are given at intervals of from two to three months, depending upon the clinical findings. With this treatment there is a minimum soft tissue and bone reaction, although decalcification can take place even when the dosage has been insufficient to produce a skin erythema.

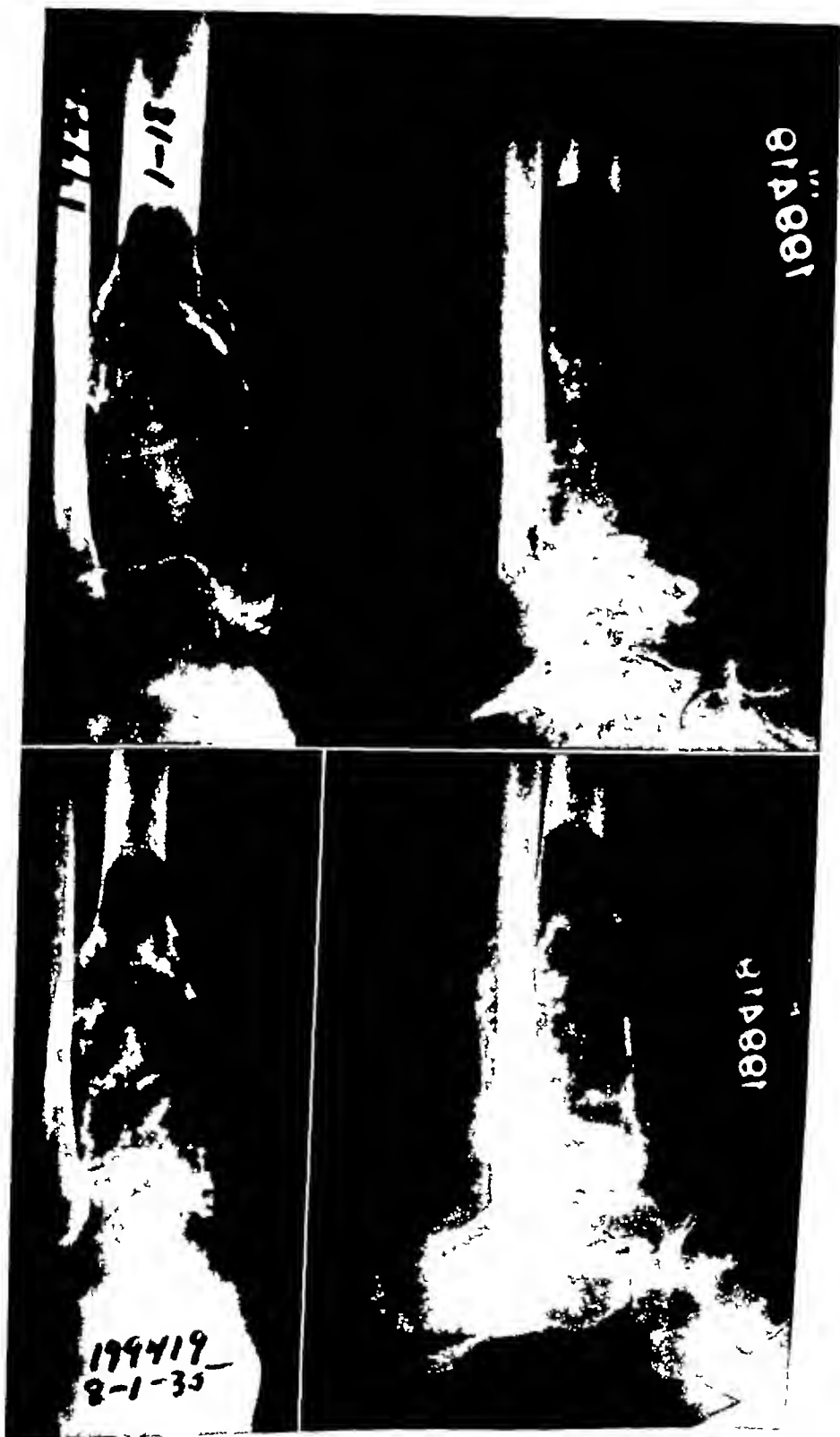
The important factor in treatment is the determination of a correct diagnosis. If there is a suspicion of malignancy present, the dosage must be raised to the upper limit of tolerance of the skin and underlying structures. Indecision and caution in the face of malignancy can lead only to disaster.

Most authors strongly advise against the placing of radium in the cavity of these tumors as tending to militate against the production of new bone to obliterate the cavity. Radiation necrosis of bone is to be avoided in all cases.

In order to determine the effectiveness of radiotherapy in the treatment of this disease, we have analyzed the results reported by some of the writers on this subject. Herendeen (10), in his first report in 1924, gave his results on 16 cases. At that time he believed that all of those cases could look forward to complete cure, or restoration of function. In 1926, in a second report (11) on the same 16 cases, he stated that 14 of these cases continued to improve or were still free of symptoms. One of the others was a case of mistaken diagnosis and the extremity was amputated. One suffered a recurrence and after further radiotherapy was reported to be well. At the present time (13), these 14 cases continue well with no evidence of recurrence or activity of the growths.

Lacharité (14) reported his results in 14 cases, in 12 of which the tumors were in the mandible or maxilla. He claimed good results in all his cases.

In 1931, Simmons (25) analyzed the cases in the Bone Tumor Registry prior to 1925. Among these cases, amputation cured 100 per cent, resection was successful in 100 per cent of the cases in which it was used. Curettage cured 63 per cent.



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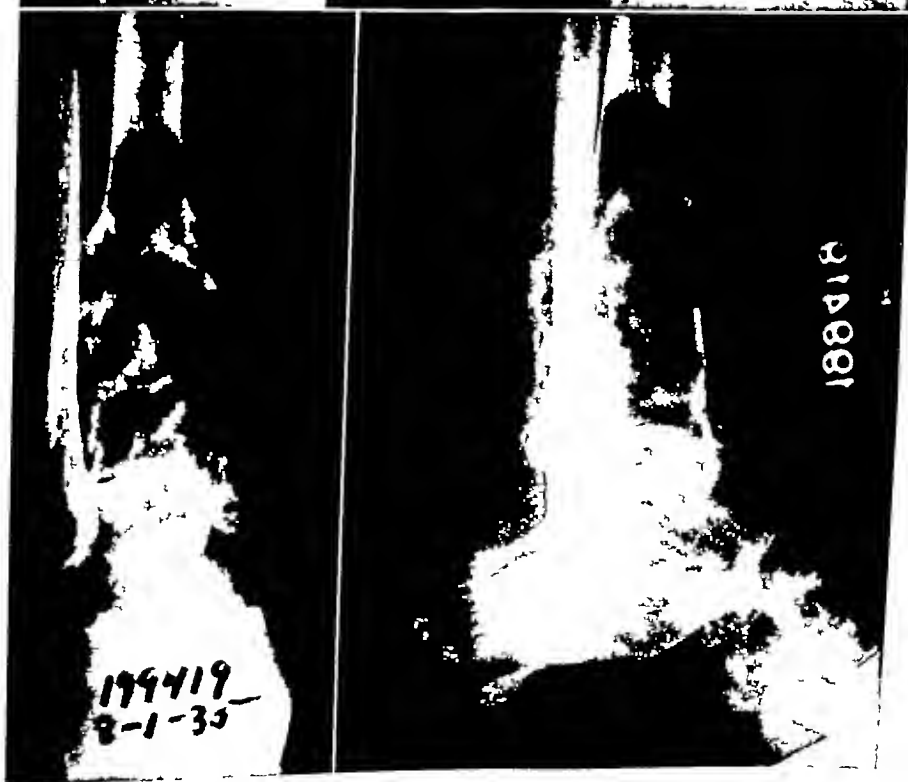
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(See legends on opposite page)

in ascribing deaths from other causes to metastases or failing to recognize the histology of the original lesion as sarcoma. In the remaining four cases, material from the original lesion was not saved for study so that the diagnosis could not be checked.

Stone and Ewing (27) reported a case of giant-cell tumor which, after curettage, had radium placed in the cavity. Eleven months later pain recurred in the leg and the lesion was again curetted and later amputated, death occurred eight months later from pulmonary metastases. They believe that radium should never be placed in the tumor cavity, but that external irradiation should be used in these cases. They state that a malignant growth developed out of a benign lesion as a result of various insults, in which curettage and imperfect irradiation played the leading parts. In Geschickter and Copeland's (8) study, described above, they believe this case was a case of "osteogenic sarcoma of the chondroblastic type, which frequently shows a resorptive giant-cell phase."

In 1931, Simmons (25) analyzed the cases of giant-cell tumors in the Bone Tumor Registry, which were treated prior to 1925, to determine the results of treatment and the incidence of malignancy among these cases. He found 82 cases available for study, and of these six died of metastases. Examination of the histories of these six cases shows that the first case was not an undoubted case of giant-cell tumor, and there was only a clinical diagnosis of metastases to the lungs without x-ray or autopsy proof. In the second case, there was no x-ray or autopsy proof of metastases to the lungs. Pneumonia and cardiac decompensation were also considered as the cause of death. The third case had biopsy proof of the original lesion. The patient improved after high voltage x-ray therapy, and died eight years later. Autopsy showed osteogenic sarcoma of the femur with metastases in the lungs. The fourth case was the one reported by Stone and Ewing and has been described above. The fifth case has an indeterminate history and poor microscopic sections. It could

not be called a proved case. The sixth case had no x-ray films. The committee thought the specimen typical of giant-cell sarcoma. The patient died, presumably of metastases, four years after curettage.

From the above summary it can be seen that Cases 3 and 4 have fairly good proof that they were giant-cell tumors that became malignant, though Case 4 is challenged by Geschickter and Copeland (8).

Dyke (5) has reported a giant-cell tumor of the knee which was treated by curettage, establishing the diagnosis microscopically. Three years later the knee became markedly swollen following an injury, and amputation was performed. Later, death resulted from generalized metastases and at autopsy the metastases were found to be identical with the original growth. From this report, the case would appear to be one of true giant-cell metastasis, and not osteogenic sarcoma. No radiation therapy was applied in this case.

In 1932, Peirce (19) reported two cases which were apparently malignancy in conjunction with giant-cell tumors. One case occurred in a boy 17 years of age, who had suffered an injury to the left lower chest. Nine months later there was a large firm mass present, and roentgen study suggested a destructive neoplasm of the tenth and eleventh ribs. Deep x-ray therapy was applied over this area, and six weeks later a thoracotomy was performed, the entire mass being removed. The pathological diagnosis was "a combination of osteogenic sarcoma and giant-cell sarcoma arising in giant-cell tumor." The second case was that of a male, 45 years of age, who had sustained an injury to the left hip nineteen years previously, with the development of a mass on the inner side of the thigh about a year later. Examination on admission showed a large lobulated tumor of the left ilium and ischium, giving the appearance of a giant-cell bone tumor with a malignant upper portion which suggested chondrosarcoma. The lungs showed round shadows suggesting metastatic sarcoma. Biopsy report "Giant-cell tumor with high degree of cellularity." Under x-ray therapy the



Fig 7 Case 2 Cyst like tumor of the left ilium with evidence of invasion along the medial border suggesting beginning malignancy in that area

X-rays of the pelvis taken in October, 1936, revealed the tumor to have decreased slightly in size from the original examination, the margins were more clearly outlined, and there was partial recalcification. No new areas of bone destruction were noted. X-ray films of the chest were negative for metastatic malignancy.

When last seen in November, 1936, the boy was unable to walk because of pain. There had been moderate weight loss, and anemia was quite pronounced. The tumor mass had decreased slightly in size. The boy's father reported in February, 1937, that the patient was receiving "serum" treatment and was "holding his own," but required opiates constantly for pain. Death occurred in July, 1937.

Case 3 M S, 33 years of age, female, reported to the clinic in July, 1929, complaining of pain and swelling in the left knee. Symptoms had been present and gradually increasing in severity for seven months. No history of injury was obtained. The condition had been diagnosed as rheumatism and treatment had consisted of physiotherapy.

Examination revealed an asymmetrical swelling immediately above the left knee with the maximum swelling on the mesial aspect of the thigh opposite the internal condyle. There was marked tenderness to

palpation and the swelling was soft and fluctuant.

X-ray examination revealed evidence of a destructive lesion involving the lower end of the femur beginning at the knee joint and extending upward for a distance of about three inches. The destruction was most marked in the internal condyle and there was some expansion of the cortex, with apparent destruction of the cortex in several places. There was evidence of some soft tissue swelling around this.

At operation (Aug 1, 1929) friable yellowish tumor tissue was encountered outside of the cortex—the cortex was extremely thin and was broken through in several places. The interior of the femur was thoroughly curetted and carbolyzed.

Pathological report was as follows: "Sections are composed of cellular tumor growth made up of dense stroma which is composed of oval and spindle-shaped cells with evenly stained nuclei and rather irregular amounts of cytoplasm. Scattered throughout this cellular stroma there are many large, irregular giant cells. These have a large amount of pale eosin-staining cytoplasm and numerous nuclei scattered throughout. They vary in shape and most of them are rounded or polyhedral. Some have as many as fifty or more nuclei. There is associated with this tumor some inflammatory reaction both acute and chronic in type." Pathological diagnosis: giant-cell tumor.

The patient had post-operative roentgen irradiation to the tumor area as follows: Aug 9, 1929. Two portals of entry, 190 kv, 50 cm FSD, 0.5 mm Cu + 1.0 mm Al filtration, 650 r units. Other series of roentgen therapy were applied in October, 1929, January, 1930, June, 1930, and September, 1930.

Progress X-ray films were taken at frequent intervals following operation and by February, 1930, the tumor was found to have decreased in size markedly and there was considerable recalcification of the tumor area.

X-ray films taken in March, 1932, revealed excellent recalcification and a sug-

the secret of the development of sarcoma in these cases lies in the intense destructive effects of the bombardment of the alpha particle and in this alone. He states that anything approaching sarcomatous transformation in cases of osteitis caused by external irradiation has never been recorded. The effects of filtered external irradiation and those of internal irradiation, such as these present, are entirely different and cannot be compared.

Sabin, Doan, and Forkner (24) injected radium chloride and mesothorium intravenously into rabbits once a month. The storage of the radio-active material in the bones gave rise to osteogenic sarcomas in two out of seven rabbits surviving from eleven to nineteen months. This seems to prove Martland's clinical study.

In order to determine the relation of the various forms of therapy to the cases of malignant variation of giant-cell tumors reported in the literature, a study of this subject was made. Peirce (19) reported two such cases, in both of which malignancy was present before any form of therapy was administered and both had a history of previous local injury. Chatterton and Flagstead (2) also reported two cases which followed repeated injury, neither of which seemed to be related to any form of therapy.

In the case reported by Dyke (5), the malignancy developed after injury and curettage and later amputation. MacGuire and McWhorter (16) reported 20 cases of giant-cell tumor, of which four died of malignant metastases. One of these four cases was treated by curettage followed by recurrence, followed, in turn, by a second curettage and the application of radium inside the cavity and roentgen therapy outside. A second recurrence preceded amputation and eventual death. The other three cases were treated by curettage followed by amputation, radiation therapy not being applied.

In the case reported by Stone and Ewing (27), the malignancy followed curettage and radiotherapy in which the radium was placed in the tumor cavity. These authors

believe that radium should never be placed in the tumor cavity as it produces an osteitis which interferes with normal recalcification. In the report by Simmons (25), there was one case of malignancy which had been treated by roentgen therapy, the patient dying seven years later of metastases. Another had had both curettage and radiotherapy, later dying of metastases.

Among the cases reported by Colcy (3) which, from the evidence submitted, appear to have been giant-cell tumors that later became malignant, we find various types of therapy employed. In seven cases surgery was used as a therapeutic agent, and six of these same cases also had radiotherapy. One case had surgery only, and one had radiotherapy only. Two of these cases also had toxins.

CASE REPORTS

Case 1 J. N., female 21 years of age, reported for examination in April, 1934, complaining of pain and swelling of the right foot and ankle. A history was given of a blow to the right ankle in June, 1933, with gradually increasing discomfort and swelling so that by November, 1933, she was forced to walk with the aid of crutches. X-ray films were taken at that time at the request of the family physician and the patient was advised that there was bone destruction and that she was to continue walking with crutches. Her general health had remained excellent and there was no loss of weight or elevation of temperature.

Examination on admission to this hospital revealed atrophy of the right calf and considerable swelling about the malleolar region of the right ankle, more marked over the medial malleolus. Movements of the ankle and mid-tarsal joints could be carried out normally. There was tenderness on pressure, and increased heat over the medial malleolus and lower three inches of the tibia. The swelling over the malleolus was soft and spongy.

X-ray examination of the ankle revealed evidence of a cyst-like tumor involving the lower three inches of the right tibia. The normal bone detail in this area was en-

six to as many as 30 or 40 nuclei. In one area there is considerable hemorrhage, which is characteristic of the tumor. Mitotic figures are very infrequent. Pathologic diagnosis: Benign giant-cell tumor."

Roentgen therapy, Jan 8, 1934. Two portals of entry, 200 kv, 0.5 mm Cu + 1 mm Al filtration, 50 cm FSD, 550 r units. This dosage was repeated on March 5, 1934, and again on Nov 9, 1934.

Recalcification of the tumor area progressed slowly but steadily. At the time of the last roentgen therapy, however, there was a large cavity that had not recalcified. At the time of the last roentgen examination in November, 1936, recalcification had largely filled in the cystic area. At the present time the patient is symptom-free and is doing heavy work without discomfort.

BONE CYST

The solitary bone cyst is found most frequently in young persons, usually under twenty years of age. The sites of election are the upper portions of the shafts of the humerus, femur, and tibia. It may occur, however, in any of the long bones.

In most cases the clinical findings are not important, and the patient is often unaware of the existence of any pathologic condition. In many cases, a pathologic fracture brings the patient to the physician.

The roentgenologic picture is that of a centrally placed area of bone destruction in the metaphysis of the bone, with a fusiform expansion of the cortex which may be of paper-like thinness. The cortex is usually intact, except where there is a pathologic fracture through this area. Trabeculae are not as prominent or numerous as in giant-cell tumor. On section, the cavity is usually found to contain a thin fluid, but there may be fibrous tissue present. The cavity usually has a connective tissue lining.

In small symptomless solitary cysts, no treatment may be necessary. Those in which pathologic fracture has occurred frequently fill in with bone as the fracture heals. In larger acute cysts, roentgen

therapy is the method of choice, in the opinion of Geschickter and Copeland (9), who advise moderate doses. Le Wald (15) has reported several cases in which roentgen therapy was very effective in obliterating bone cysts.

In dealing with multiple cystic lesions or osteitis fibrosa cystica, we have a condition which is now generally conceded to have an endocrine etiology. It is associated with hyperparathyroidism, and has a definite clinical syndrome. There may or may not be an associated adenoma of the parathyroid gland. There is usually an elevation of the serum calcium, a lowering of the serum phosphorus, and an increase in the excretion of calcium. There may be deposition of calcium in the kidneys. The bones are generally demineralized, and there is sometimes a characteristic roentgen picture in the skull, spine, and long bones.

The surgical treatment consists in extirpation of the tumor of the parathyroid gland if present, or of a portion of the hyperactive gland. Irradiation of the parathyroid glands has been reported by Merritt and Lattman (18) and others. This has resulted in improvement or disappearance of the osseous lesions.

CASE REPORT

Case 5. I. B., female, 17 years of age, was seen in June, 1934, because of a swelling of the left arm which had been slowly progressive since December, 1933. Pain and tenderness had been prominent features in the early stage but recently had subsided. Treatment had consisted of local applications and chiropractic adjustments.

Examination disclosed a fusiform swelling at the level of the junction of the upper and middle thirds of the left arm. This was of bony hardness and slightly tender on deep palpation. The x-ray examination showed an expansile cystic process in the upper half of the left humerus. The tumor measured 5.5 cm by 10 cm in its greatest diameters. It contained numerous bone trabeculations throughout its extent and had fairly well defined margins.

turely destroyed, the cortex was markedly expanded and in some places appeared to be absent, giving the typical appearance of giant-cell tumor

A punch aspiration biopsy of the interior of the bone was obtained, the pathological report on which was as follows "The section consists of small bits of tissue composed of oval or round cells with many large giant cells of the foreign body type scattered throughout. There is nothing to suggest malignancy benign giant-cell tumor"

X-ray therapy was administered as follows May 10, 1934 two portals of entry, 190 kv, 0.5 mm Cu + 1.0 mm Al filtration, 50 cm, FSD 520 r units over each portal. This was repeated Aug 20, 1934, and again Nov 21, 1934

Because of failure of the tumor area to show much recalcification and because an area of decreased density had developed in the lower end of the fibula which suggested tumor formation, the tumor was explored in December, 1934. Grayish-yellow friable tumor tissue was encountered immediately beneath the subcutaneous tissues, and extended within the shell of bone. The interior of the bone was thoroughly curetted and the wound closed. Pathological report of the tumor removed was as follows "Sections from curettings show for the most part the typical histological picture of giant-cell tumor, *i.e.*, numerous large giant cells of the foreign body type with ten to fifteen nuclei and a stroma composed of oval or short spindle-shaped cells. In some sections, however, particularly those from deep within the tumor tissue, the stroma cells tend to become more of the adult type. The cells are more elongated and have more cytoplasm and the nuclei are hyperchromatic, many of them undergoing mitosis. In these same areas the stroma cells have undergone malignant change in that there is marked variation in the size and shape of the cells, the nuclei are hyperchromatic, and many of them are

grouped together forming true tumor giant cells. At the present time it must be considered histologically malignant"

Amputation was recommended, but the patient's family would not give their consent. Further roentgen therapy was given on April 1, 1935, and again on July 3, 1935. The latter was given because of the lesion's extending upward in the shaft of the tibia.

Examination in September, 1935, revealed a soft tissue swelling over the external malleolus and a biopsy of this area was obtained. The pathological report on this was as follows "Section from the lower end of the fibula shows considerable dense, pink staining, fibrous stroma with cellular areas scattered throughout. The sparsely nucleated and richly nucleated tissue is arranged in interlacing whorls and columns. The more cellular areas are composed of long spindle-shaped, oval, or round cells. Here the cells are much larger, have abundant cytoplasm and hyperchromatic nuclei. Mitotic figures in these areas are fairly abundant, three being seen in a simple high power field. There are no giant cells or characteristic stroma of giant-cell tumor which would suggest that this tumor arose in a giant-cell tumor of bone. It is a typical fibrosarcoma of rather above the average activity"

Permission for amputation below the knee was obtained and carried out on Oct. 23, 1935. Palpable inguinal glands were removed at operation two weeks later and metastatic involvement found on microscopic examination. X-ray therapy was subsequently given over the right groin.

X-ray films of the chest were negative for metastatic malignancy. The patient was last seen June 5, 1937, when examination revealed no evidence of recurrence of the tumor.

Case 2 M. D., 14 years of age, male, was admitted June 29, 1935, complaining of a painful swelling over the left hip. A history was given of a fall on the left hip while pole-vaulting two months previously.

Fig 1 (upper) Case 1 Typical giant-cell tumor before radiation therapy (April 30, 1934)
Fig 2 (lower) Case 1 Roentgen appearance six months after beginning radiation therapy
Partial recalcification of the tibia Evidence of a destructive process in the external malleolus



Fig 11 Case 5 Condition of tumor twenty months after the first radiation therapy (March 14 1930)
 Fig 12 Case 5 Evidence of malignant destruction of the cortex seven weeks following the previous film
 Fig 13 Case 5 From tumor mass arising in bone cyst The tumor is composed of spindle cells of varying size and tumor giant cells Mitotic figures are abundant and hemorrhage is present about the blood vessels
Osteogenic sarcoma

cortex in this portion was missing and there was evidence of a soft tissue tumor around this area. It definitely suggested malignant tumor. X-ray films of the chest were negative for malignancy.

On April 27, 1936, the arm was again explored and tumor tissue encountered immediately beneath the subcutaneous layer. Pathologic examination of this tissue revealed "Tumor tissue composed of rather loosely packed, plump, oval, and spindle cells which vary markedly in size and staining reaction. The largest cells present hyperchromatic and vesicular nuclei and rather abundant eosinophilic, finely granular cytoplasm. Giant cells of the tumor variety are rather frequently seen. The tumor giant cells have from two to four or five nuclei, some of which are very large and bizarre in appearance. The foreign body giant cells have many nuclei and the usual central grouping. Mitotic figures are fairly common and when they occur are atypical. No bone formation or osteoid tissue formation is seen. Pathologic diagnosis: *Osteogenic sarcoma*."

Subsequently roentgen therapy was given as follows: 200 kv, 50 cm FSD, 0.5 mm Cu + 10 mm Al filtration.

From 200 to 250 r units were applied to each of two ports on alternate days until approximately 2,200 r units had been applied to each port.

The tumor did not regress following this therapy. X-ray examination of the chest on Aug 10, 1936, revealed evidence of metastatic tumor nodules in both lungs. The patient expired at home Sept 3, 1936.

CHONDROMA

A chondroma is a benign centrally placed lesion occurring most frequently in the small bones of the hands, feet, ribs, or spine. It may occur in the other long bones, or flat bones. In most instances, it is found in young adults. The tumor is very slow-growing, and may appear to be stationary. The symptoms are mild, and may consist of soreness or tenderness over the affected area.

The roentgen picture is that of a cyst-like tumor, centrally placed. The cortex is thin and unbroken. Trabeculae traversing the tumor is the usual finding. They present a picture similar to that of bone cyst or giant-cell tumor except for their point of origin, which is commonly in the small bones of the feet and hands. They are usually oblong in shape, and extend

Pain appeared two days later and continued intermittently until two weeks prior to admission, when it became more severe and constant, and swelling was noticed for the first time.

Examination revealed no abnormalities other than the findings relative to the left hip and ilium. There was a visible mass involving the left side of the pelvis which, on palpation, was found to be firm and fixed to the crest and wing of the ilium. In extent it reached laterally and downward to within a short distance of the greater trochanter, backward from the anterior superior spine for a distance of five inches along the crest of the ilium, and mesially to within two inches of the umbilicus. The hip joint was freely movable without pain.

X-ray films of the left ilium revealed a cyst-like tumor involving the entire left ilium with a tumor mass, roughly oval in shape, extending laterally into the soft tissues. Along the medial border of the tumor there was evidence of invasion of the ilium, suggesting that there was malignancy present.

On July 3, 1935, operative exposure of the tumor was carried out. The tumor tissue was found to be friable, grayish in color, and extremely vascular. Microscopic examination of the frozen sections suggested giant-cell tumor. An attempt was made to curet the tumor mass, but this was abandoned because of the extensive hemorrhage encountered.

The pathological report on the sections was as follows: "Sections taken from bits of tissue removed show the same composed chiefly of giant cells of two distinct types, the first being the usual foreign body type with abundant pink staining cytoplasm and many round or oval nuclei. The second type of giant cell is the typical tumor giant cell with one or more irregular hyperchromatic nuclei. In some of these latter giant cells the nuclei are undergoing mi-

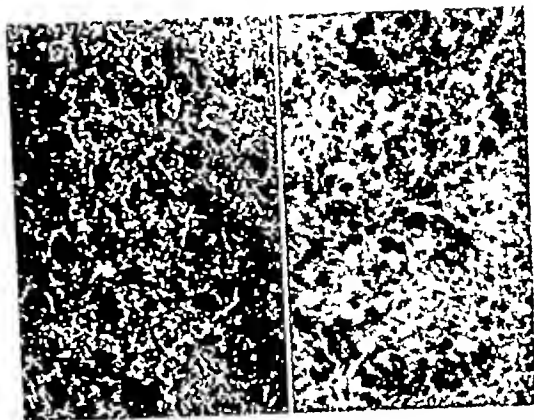


Fig 5 (left) Case 1 May, 1934, first biopsy showing many large multi nucleated giant cells of foreign body type with a stroma of small oval or spindle shaped cells. Benign giant-cell tumor.

Fig 6 (right) Case 1 Material from operation. There are a few giant cells of foreign body type but with the stroma definitely sarcomatous and composed of spindle cells of varying size and shape arranged in whorls. Mitotic figures are abundant. Osteogenic sarcoma.

tosis. Aside from the giant cells there are many tumor cells of varying size and shape distributed throughout the rather scanty stroma. The number and type of giant cells and tumor cells vary from microscopic field to microscopic field. In some the tumor giant cells predominate and in others the foreign body giant cells predominate. Diagnosis: osteogenic sarcoma with tumor giant cells and foreign body giant cells, probably arising as a variant of the giant-cell tumor."

Treatment consisted of five series of roentgen therapy applied through three portals of entry, anteriorly, posteriorly, and laterally. The factors used were 200 kv, 50 cm FSD, 0.5 mm Cu + 1.0 mm Al filtration, 700 r units. This was repeated on five different occasions between July 15, 1935, and Oct 5, 1936. Preceding and interspersed between these treatments he was given artificial fever therapy. His body temperature was raised to approximately 105° F (rectal temperature) and maintained at that level for five-hour intervals on twelve occasions.

effect on the tumor cells, we raise the question of increasing our roentgen dosage to higher limits. This would necessarily mean that the time interval between the roentgen series would be lengthened and fewer doses be administered.

We believe that roentgen therapy and surgery should not be combined in the treatment of giant-cell tumors. The possibility of increased irritation resulting from such a combination may possibly be a factor in the transformation from a benign tumor to a malignant one. In several malignant variants reported in the literature such a possibility has been mentioned.

A short discussion of benign bone cyst has been presented, with special reference to roentgen therapy. One case is reported in which roentgen therapy was used. The cyst showed excellent recalcification but after eighteen months an osteogenic sarcoma developed which resulted in death to the patient. It is difficult to understand the development of osteogenic sarcoma in a case which calcified so well under roentgen therapy.

Benign chondroma is briefly discussed and one case is reported. This case received roentgen therapy and showed moderate recalcification but finally had surgical curettement. This again demonstrates that these cases are radioresistant and require large amounts of irradiation to destroy them.

BIBLIOGRAPHY

- (1) BECKER F. Sarcoma of the Knee Joint after X-ray Treatment. *Deutsche Ztschr f Chir* 1936 248, 11-23
- (2) CHATTERTON C C, and FLAGSTEAD A E. Peculiar Behavior of Giant cell Tumors. *Jour Bone and Joint Surg* January, 1927 9, 111
- (3) COLLY, WILLIAM B. Malignant Changes in So-called benign Giant cell Tumors. *Am Jour Surg*, June, 1935 28, 768-820
- (4) DESJARDINS, ARTHUR U. The Radiosensitivity of Tumors Derived from Cartilage. *Am Jour Cancer*, May 1933 18, 15-27
- (5) DYKE, S C. Metastasis of "Benign" Giant-cell Tumor of Bone. *Jour Path and Bact* March 1931, 34, 259-263
- (6) EVANS W A, and LEUCUTIA, T. Value of Roentgen ray Therapy in Primary Malignant Tumors and Benign Giant-cell Tumor of Bone. *Am Jour Roentgenol and Rad Ther* October, 1928, 20, 303-338
- (7) EWING JAMES. Radiation Osteitis. *Acta Radiol* 1926, 6, 399
- (8) GESCHICKTER C F and COPELAND M M. Recurrent and So-called Metastatic Giant-cell Tumor. *Arch Surg*, May, 1930 20, 713-755
- (9) Idem. Tumors of Bone. Revised Edition. *Am Jour of Cancer*, New York, 1936
- (10) HERENDSEEN RALPH E. The Roentgen Ray in the Treatment of Giant-cell Tumors. *Am Jour Roentgenol and Rad Ther* August, 1924 12, 117
- (11) Idem. Diagnosis and Results in the Radiation Treatment of Some Medullary Bone Tumors. *RADIOLOGY*, August, 1926 7, 140-143
- (12) Idem. Results in the Roentgen ray Therapy of Giant-cell Tumors of Bone. *Ann Surg*, January 1931 93, 398-411
- (13) Idem. Personal communication
- (14) LACHARITÉ H. Radiotherapy of Giant-cell Tumors. *Jour de Radiol et d'Electrol* December 1928 12, 521-535
- (15) LEWALD L T. Roentgen Therapy of Giant cell Tumor and Osteitis Fibrosa Cystica. *RADIOLOGY*, July 1930 15, 136-138
- (16) MACGUIRE, C J JR and MCWHORTER J E. Sarcoma of Bone. Analysis of Fifty Cases. *Arch Surg*, November, 1924, 9, 545
- (17) MARTLAND HARRISON S. The Occurrence of Malignancy in Radio-active Persons. *Am Jour Cancer* October 1931, 15, 2435-2516
- (18) MERRITT E A, and LATTMAN I. X ray Treatment in Hyperparathyroidism. *RADIOLOGY*, June 1936, 26, 673-679
- (19) PEIRCE, CARLETON B. Giant cell Bone Tumor. A Consideration of the Morphology of this Neoplasm the Response to Surgical and Radiation Therapy and Report in Detail of Two Apparently Malignant Cases. *Am Jour Roentgenol and Rad Ther*, August, 1932, 28, 167-188
- (20) Idem. Giant-cell Bone Tumor. Some Considerations of Treatment. *RADIOLOGY* October 1933, 21, 348-351
- (21) PEIRCE CARLETON B and LAMPE ISIDORE. Giant-cell Bone Tumor. Further Observations on Treatment. *Jour Am Med Assn* Dec 5 1936 107 1867-1871
- (22) PFAHLER, GEORGE E and PARRY LEO D. The Treatment of Giant-cell Tumors by Roentgen Irradiation. *Am Jour Roentgenol and Rad Ther* August 1932 28, 151-166
- (23) PREMISTER D B. Radium Necrosis of Bone. *Am Jour Roentgenol and Rad Ther* October 1926 16, 340
- (24) SABIN F R, DOAN C A and FORKNER C E. The Production of Osteogenic Sarcomas and the Effects on Lymph Nodes and Bone Marrow of Intravenous Injections of Radium Chloride and Mesothorium in Rabbits. *Jour Exper Med* August 1932 56, 267-289
- (25) SIMMONS CHANNING C. Malignant Changes Occurring in Benign Giant-cell Tumors of Bone. *Surg Gynec and Obst* October 1931 53, 469-478
- (26) SOSUR R. The Evolution and Treatment of Giant-cell Tumors of Bone. *Scapell* 1931, 84, 525
- (27) STONE W S and EWING JAMES. An Unusual Alteration in the Natural History of a Giant-cell Tumor of Bone. *Arch Surg*, September, 1923 7, 280-296



Favorite



Search

DOUB, HARTMAN, AND MITCHELL BENIGN BONE TUMORS 431

gestion of a fracture line through the in joint fluid There was a palpable enlargement of the inner condyle of the femur
tumor area

The patient was not seen again in the and slight tenderness on pressure

ard One lived for thirteen years and the other is still living after twelve years. The former did not have skin metastases until twelve years after operation and the latter eight years after operation. Neither case was used in the computation of the post-operative appearance time of skin metastasis because it was felt neither represented "the run of the mill." Something beside surgery and radiation restrained the growth of the cancer cells in these two cases. Give surgery all credit, radiation can take none. Yet we can hardly think of surgery restraining cancer cell growth rather, must we fall back on some process of cell growth peculiar to the tumor itself or to the natural resistance of the individual, each or both contributing to the establishment of an approximate equilibrium.

One of the two cases just referred to that lived the longest was definitely benefited by x-irradiation, once the skin metastases appeared, and that is true for the most part of the other members of the group, although my experience has been that when there has been regression of one set of skin nodules a set will appear elsewhere, and it is not long before pulmonary and skeletal changes take place, followed by exitus.

Once skin metastases are present, it matters little what was the route. On the other hand, if post-operative irradiation is to be continued, then many more fields must be employed than is generally the custom. It is not sufficient to treat the affected chest wall, axilla, and clavicular chain of lymphatics, but it is quite as necessary to treat the mediastinum and the lymphatics of the opposite breast over a protracted period with a view to slowing up the growth of any remaining cancer cells, in the hope that, if implanted elsewhere, they may be less viable.

If post-operative irradiation is of any value in inhibiting cell growth and the distribution of cancer emboli, pre-operative irradiation ought to be of greater value, for with the breast and axilla intact, larger amounts of radiation may be administered to these areas without damage to the chest wall and axillary vessels.

It has been shown that one-third of the cases of cancer of the breast can be sterilized by x-irradiation and that, properly administered, pre-operative irradiation does not erect barriers to effective radical surgical intervention.

Master surgeons confess that there is little likelihood of any change in surgical technic that will alter the percentage rate of present-day survivals. If that is the case, some group must have the courage to endorse pre-operative irradiation conceived broadly—not for the glorification of radiology but in a serious effort to evaluate once and for all whether this added pre-operative therapeutic routine will measurably assist in prolonging in comfort the lives of these cancer patients.

Such a program will presuppose an efficiently functioning tumor clinic where internist, pathologist, radiologist, and surgeon will have a common understanding of the problem confronting them, where proper diagnostic x-ray and blood studies may be done, where the pathologist may help chart the course of the radiologist and the experienced surgeon will foil the less experienced who would elect unwise, unradical procedures.

REFERENCES

- (1) ACKLAND T. H. Notes on the Occurrence and Treatment of Metastases in Carcinoma of the Breast. *Med Jour Australia* July 20 1935 2, 80-83.
- (2) O'BRIEN F. W. Irradiation of Primary Cancer of the Breast. *New England Jour Med.* May 8 1930 202, 897-901.

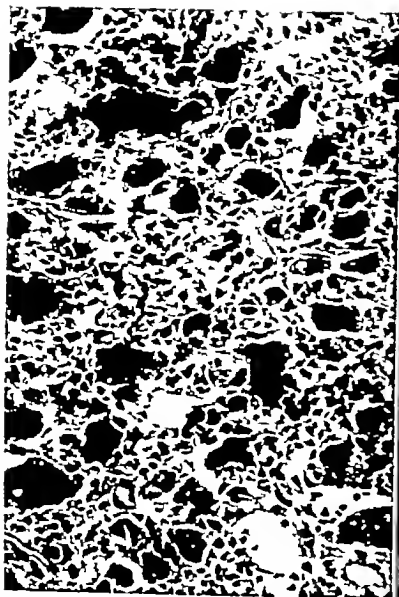


Fig 8 Case 2 The tumor is made of large foreign body giant cells The stroma cells are sarcomatous They vary in size and shape and many are undergoing mitosis
Osteogenic sarcoma in giant-cell tumor

Fig 9 Case 5 Cystic lesion of left humerus before radiation therapy

clinic until April, 1934 X-ray films taken at that time revealed a complete fracture of the femur at the upper level of the tumor with telescoping of the shaft through the tumor area This condition has persisted since then The patient is able to walk without external support and without discomfort, and has refused further surgery

Case 4 A T, male, 40 years of age, was admitted Dec 22, 1933, complaining of pain in the left knee A history was given of a blow over the medial condyle of the femur by a chassis frame two months previously There was no immediate disability, but he continued to have discomfort in the knee following the accident On one occasion the knee gave way from under him, but there was no history of locking Examination of the left knee on admission revealed a visible swelling immediately above the knee joint on the mesial aspect The range of motion in the knee was normal and there was no increase

X-ray examination revealed a large area of decreased density representing a cyst-like condition in the internal condyle of the femur There was some trabeculation present throughout this area The cortex was intact and the contour of the lower end of the femur was normal, suggesting a benign giant-cell tumor

Operation was performed on Dec 27, 1933 The cortex over the internal femoral condyle was extremely thin and broken through easily The interior of the bone was found to be filled with tumor tissue, which was vascular and grayish in color This was thoroughly curetted, removing as much of the tumor tissue as possible Microscopic examination of this tissue was as follows "Section shows a dense fibrous stroma made up of spindle cells mixed with somewhat rounded cells having oval or rounded vesicular nuclei and throughout the stroma are distributed numerous large foreign body giant cells with from five or

received the same dose in thirteen fractions, given on thirteen consecutive days. These authors also carried out similar experiments with radium. Both series of experiments led to the same conclusions, summarized by the authors as follows: "A dose applied in a single sitting has a much more definite biologic effect on the surface of the skin than the same dose has if divided."

All experimental work on this subject substantiated these conclusions and elaborated them in certain details. For example, Schwarz showed that interruption of the irradiation for a few hours only led to the production of a weaker erythema reaction. Other investigators, Liechti, in Germany, and Stenstrom and Mattick, in the United States, gave estimates of the degree the total dose would have to be increased, if divided, to produce the same effect as if given at one time. Reisner did some comprehensive experiments on this problem. He showed, for example, that if the 100 per cent skin erythema dose is not given in one session but is given in divided doses, then at the end of two days 130 per cent, in three days 150 per cent, and in seven days 210 per cent of the erythema dose will have to be given to produce an erythema reaction. In summary, the smaller the individual dose, the greater the irradiation intervals, so much more will the total dose have to be increased to produce the same effect as that from irradiation given in one session.

It has been found out that these observations are valid in the case of tissues other than the skin. Wintz made similar observations on the ovary. In 1926, I reported, apparently as the first, some observations on the decreased effect of divided doses on the hair as shown by some experiments on rabbits, some observations which were later confirmed by Miescher and Gunsett. These experiments showed that even a few hours' interval definitely decreases the effectiveness of irradiation, and that the dose must be increased to get the initial effect.

Wintz, in 1920, first gave a theoretical explanation for this course of events. "We explain this fact in this manner: the cells are only injured by insufficient irradiation and are not killed off. In the time to the next irradiation, which is to increase the effect of the first dose, the cells recover rapidly. The second dose of radiation is given to cells in a different condition from that which they were in shortly after irradiation, and are cells which have recovered more or less completely from the dose. To each successive dose an increment of energy must be added which depends on the recuperative power of the cells for the production of a constant biologic effect."

The possibility of the cumulation of the radiation effect was contrasted with the possibility of recovery from the radiation effect. This attitude seemed to nullify the basic idea of any divided dose method of radiation which had for its foundation the cumulation of radiation effects. Because cells may recover from a radiation injury which does not kill them off, it was thought that a divided dose method of irradiation would be of slight effectiveness. Divided dose methods, therefore, came to be regarded somewhat disparagingly. The method of the single session, or at least a concentrated method of treatment, seemed to have been solidly established by the classic work of Seitz and Wintz in 1920, and at the same time to have relegated the divided dose method of Freund to the discard. The victory of the single dose method seemed to be strengthened by a series of other factors. The brevity of the treatment gave it an extraordinary advantage from the standpoint of saving time and material. The fact that roentgen therapy was given in a single session placed it in position to compete with the surgical methods of treating malignant tumors. Only by a single dose method was it possible to fulfill the idea of Perthes of obtaining a definite opinion on the relationships of dose and effect.

But in spite of so many points favoring

Laboratory examination showed a normal urinalysis, hemoglobin, 68 per cent, red blood corpuscles, 4,210,000, white

The wound healed *per primum*, and to obviate the possibility of a pathologic fracture, a platform splint was applied

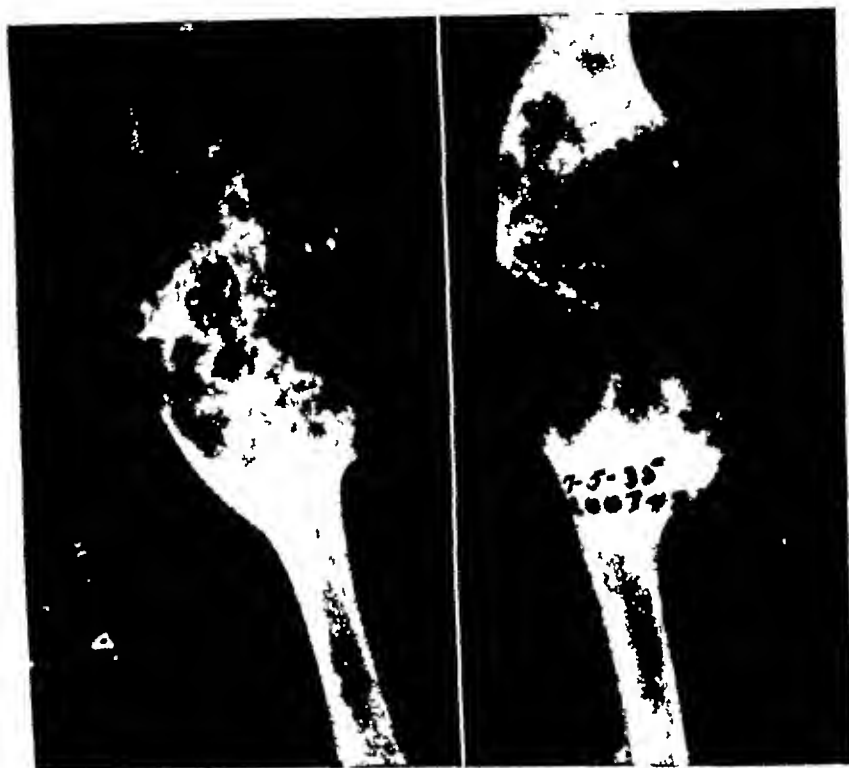


Fig 10 Case 5 Considerable recalcification of the tumor eleven months after beginning radiation therapy

blood corpuscles, 7,100, polymorphonuclears, 69 per cent, Wassermann, negative, serum calcium, 9.8, phosphorus 3.84, phosphatase, 8.30

June 9, 1934, an exploratory operation was performed. The cortex of the humerus was extremely thin and easily broken through. The large cavity which was thus entered contained nothing but some blood clots. The interior was curetted but only blood was obtained. A portion of the shell-like cortex was removed for biopsy. Report on the pathologic examination was as follows: "Sections from wall of cyst removed shows thin, pink-staining, sparsely nucleated, fibrous tissue with occasional giant cells scattered throughout and some trabeculae of bone. There is nothing to suggest malignancy or giant-cell tumor. Pathologic diagnosis: Benign bone cyst."

Roentgen therapy was given as follows (Aug 21, 1934) two portals of entry, 190 kv, 50 cm FSD, 0.5 mm Cu + 1.0 mm Al filtration, 500 r units. Similar amounts of roentgen therapy were applied on Nov 19, 1934, and April 20, 1935.

X-ray films taken Nov 19, 1934, and subsequently, revealed a progressive amount of recalcification of the cyst. The patient returned to school and had no further discomfort in the arm until March, 1936. X-ray films taken at that time, however, showed no decalcification. She returned for observation one month later with increased pain in the left arm, and on clinical examination the arm was found to be increased in circumference, with a painful soft area on the lateral aspect of the tumor. X-ray films revealed an area of decalcification and destruction along the anterior surface of the tumor mass. The

for the general conception of metabolic and structural change the specific conception of mitosis cannot be discussed further at this time. But it is an obvious and established fact that the results of Schwarz, Regaud, and Schinz are at variance with the teaching of Kroenig and Friedrich and of Seitz and Wintz. This is the more remarkable because both theories were established on valid experiments, and could be substantiated by suitable clinical experience. Thus there arose a split in roentgen therapy, which all who were roentgenologically active ten years ago can remember vividly, if at times unpleasantly.

Gottwald Schwarz, by his restless and many-sided activities, was in position to adduce evidence in support of both sides of the contention, and was, so to speak, predestined to produce a synthesis of both theories. This actually happened. Starting with the demonstration he himself made that an intensive irradiation is always of greater biologic effectiveness than a divided one, he expressed in 1924 the following thoughts: "*It is possible that the gain (Pluseffekt) from increasing the intensity is effective in greater degree in tumor tissue than in the skin*". Schwarz hereby coined the fundamental conception of injury ratios which are the relationships of the radiation damage in tumor tissue to the radiation damage in normal tissue. On the basis of his own investigations he explained his concept in the following words: "I showed in 1914, and Regaud and Lacassagne and Monod showed later, that with regard to increasing sensitivity during mitosis divided doses under certain conditions produce greater injury than a single full dose. The injury to the normal tissues (skin) is in the case of divided doses (and even with high partial doses at short intervals, as I for the first time recently showed) definitely less. In this case the injury quotient is greater from divided doses, or, as one might say, the 'electivity' of the radiation is increased."

To elaborate this new theory of Schwarz

the following may be adduced. A radiation concentrated within a short period of time acts on all tissues more intensively than a radiation spread out over a long period of time, and this difference of effect is manifested differently in different tissues. Division of a skin erythema dose into two equal halves given at an interval of twenty-four hours may, for example, produce a markedly less effect in the skin than in a tumor or in some other tissue. If this is the case, then a slight addition of radiant energy can compensate for the decreased effect in and around the tumor, while it is not sufficient to balance-off the decreased effect in the skin. If, as a result of this, the fractionated irradiation has a disadvantage which is not present in the case of concentrated irradiation, namely, that to produce the same biologic effect a greater dose is necessary and a consequent prolongation of the treatment time, then this drawback is counterbalanced by the fact that an equally strong effect in the tumor is produced with less effect in the skin, or by the fact that an equal effect in the skin is accompanied by a greater effect in the tumor.

In this regard there is the analogy of the effectiveness of a heavy and a light filter. With a heavy filter the time of irradiation necessary to produce a skin reaction is longer than it is when a light one is employed. But the equal effect in the skin is associated in the case of the heavy filter with a relatively greater effect in the depths than is the case with the light filter. We say that with the heavy filter the depth quotient is better, just as we say, in the words of Schwarz, that with fractionated irradiation the injury-quotient in tumor tissue is better.

It is to Regaud that credit is due for the experimental demonstration of the correctness of this conception. Regaud treated the testis of the rabbit with roentgen rays. He tried to establish the dose which in a single application would produce permanent sterilization, in other words, a complete destruction of

along the medullary canal. These tumors are composed primarily of cartilage, and when sectioned have the typical gelatinous appearance seen in cartilaginous growths. In small tumors, they are apt to be rather solid and contain some calcification. In the large specimens, cystic changes may be present, and these cystic areas contain a thick fluid. The tumors are relatively avascular.

Benign chondromas have always been regarded as relatively radioresistant and, therefore, few attempts have been made to treat them by radiation therapy. In tumors of small bones, resection or curettage followed by cauterization usually effects a permanent cure. Geschickter and Copeland (9) state that in their series of chondromas occurring in the large bones, recurrences after operation totaled 25 per cent. They believe that in cases in which complete removal is difficult or dangerous, irradiation should be used. Desjardins (4) reports one case in which radiation therapy distinctly relieved pain, and the x-ray appearance of the tumor was improved. We have treated one case which showed some recalcification, but no complete disappearance of pain and tenderness.

Case 6. H. R. S., white female, 23 years of age, was first seen in 1933, complaining of a pain in the right shoulder. This was aggravated by carrying heavy objects. There was increasing weakness of the right arm.

Physical examination revealed no deformity of the shoulder or upper extremity, no limitation of motion. The maximum point of tenderness was over the acromion process of the scapula.

Roentgen examination disclosed a cyst-like tumor of the acromion process of the scapula, with marked expansion of the cortex. The cortex was intact. The first impression was that it was a benign giant-cell tumor.

Roentgen therapy was applied on four different occasions at intervals of from two to four months. The factors used were 200 kv, 0.5 mm Cu + 1.0 mm Al, 50 cm FSD. The dosage varied from 550 r to 600 r through each of two portals.

The pain and weakness persisted unless the arm was put at rest with support, and it was finally decided to surgically explore the tumor. The lesion was thoroughly curetted and cauterized with phenol on Oct 16, 1935. The material removed was white and cartilaginous. Pathologic diagnosis: Benign chondroma.

The patient gradually improved following the operation. The improvement has been gradual but steady, and at this time the arm is in full use, with very few symptoms.

SUMMARY

The major portion of this discussion has been devoted to the technic and results of the application of radiotherapy to giant-cell tumors of bone. The recorded statistics tend to show a high percentage of cured cases resulting from this method.

There is an increasing number of cases reported in the literature in which there is a transition from benign giant-cell tumor to osteogenic sarcoma. The etiology of this transition is not clear at this time, but injury or chronic irritation occupies an important place in these case histories. It is difficult to determine whether or not radiotherapy is a factor in this process, owing to the small number of carefully studied cases available for review. Malignant variants, however, are being recorded more frequently during recent years. Whenever metastases are found they show the histology of osteogenic sarcoma and not of the original giant-cell tumor.

In our case, reported above, a typical giant-cell tumor of the lower tibia received several series of roentgen therapy. After several months an osteolytic area was noted in the external malleolus. Biopsy of this disclosed evidence of fibrosarcoma, and metastases also were histologically fibrosarcoma. This illustrates a case in which transition from benign giant-cell tumor to fibrosarcoma occurred during conservative roentgen therapy. What rôle this therapy may have played in the transition is open to question.

Since small, frequently repeated doses of roentgen therapy may have a stimulative

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To elaborate this new theory of Schwarz

the following may be adduced. A radiation concentrated within a short period of time acts on all tissues more intensively than a radiation spread out over a long period of time, and this difference of effect is manifested differently in different tissues. Division of a skin erythema dose into two equal halves given at an interval of twenty-four hours may, for example, produce a markedly less effect in the skin than in a tumor or in some other tissue. If this is the case, then a slight addition of radiant energy can compensate for the decreased effect in and around the tumor, while it is not sufficient to balance-off the decreased effect in the skin. If, as a result of this, the fractionated irradiation has a disadvantage which is not present in the case of concentrated irradiation, namely, that to produce the same biologic effect a greater dose is necessary and a consequent prolongation of the treatment time, then this drawback is counterbalanced by the fact that an equally strong effect in the tumor is produced with less effect in the skin, or by the fact that an equal effect in the skin is accompanied by a greater effect in the tumor.

In this regard there is the analogy of the effectiveness of a heavy and a light filter. With a heavy filter the time of irradiation necessary to produce a skin reaction is longer than it is when a light one is employed. But the equal effect in the skin is associated in the case of the heavy filter with a relatively greater effect in the depths than is the case with the light filter. We say that with the heavy filter the depth quotient is better, just as we say, in the words of Schwarz, that with fractionated irradiation the injury-quotient in tumor tissue is better.

It is to Regaud that credit is due for the experimental demonstration of the correctness of this conception. Regaud treated the testis of the rabbit with roentgen rays. He tried to establish the dose which in a single application would produce permanent sterilization, in other words, a complete destruction of

SKIN METASTASIS IN POST-OPERATIVE IRRADIATED BREAST CANCER¹

By FREDERICK W. O'BRIEN, M.D., Boston

THE appearance of single or multiple metastatic skin nodules secondary to breast cancer is disquieting not alone to the patient but to the informed clinician because of his knowledge that it is a manifestation of a terminal process.

Since the advent of intensive fractionated high voltage x-irradiation and its rather universal utilization, one might expect from theoretical considerations to encounter secondary skin deposits in breast cancer, irradiated post-operatively, less frequently than formerly, or at least to have their appearance delayed.

Nevertheless they have continued in my clinic with disquieting frequency, so that it seemed of importance to survey them in an attempt to establish the chronological relationship, if any, between the kind of x-irradiation and the appearance of the metastatic skin nodule.

In a period of fourteen years (1923 to 1936, inclusive), 407 cases of pathologically proven breast cancer were operated upon at the Boston City Hospital. They constituted 0.3 per cent of the surgical admissions for that period. Of these breast cancers, 255, or 62.6 per cent, were treated post-operatively by x-ray.

Single or multiple skin nodules appeared in 54 of these 255 cases, or in 21.1 per cent. In 22 cases, or 41.7 per cent, skin metastases appeared on an average of 8.14 months after operative interference, which was frankly incomplete. In 32 cases, or 58.3 per cent, skin metastases appeared on an average of 14.6 months following the classical radical resection. There were 10 of these cases, however, that had palpable axillary and supraclavicular glands before operation and should not have been subjected to the radical operation. Skin metastases did not appear for an average

of 18.5 months in the 22 cases without palpable nodes that were operated upon radically. These figures closely parallel those of Ackland (1).

On the face of it, these statistics indicate that the appearance time of skin metastasis in this group of breast cancers treated post-operatively by x-rays was directly related to the extent of the growth at the time of operation. There was no evidence that the kind of tumor influenced the appearance time of skin metastases. It was clear, however, that skin metastasis appeared with relative promptness following incomplete or injudicious surgery. Paradoxically, it would seem, in our reputedly enlightened age, 20 of the 22 frankly incomplete operations in the group were done since 1929.

The x-ray treatment was given on the average about four months after operation, not early enough perhaps but at least an improvement over the group reported earlier (2), in which in one-half the cases x-ray therapy was not instituted for more than ten months following surgery.

The majority of the cases showing secondary skin nodules had adequate x-ray therapy as judged by the mode of the era in which they were treated. The earlier ones were not irradiated in as thoroughgoing a fashion as is our wont to-day. Statistically there is no evidence that the appearance of skin metastasis was related to the kind or amount of irradiation but rather to the extent of growth and the kind of operation performed.

The latter statement holds as a generalization, but only a cursory experience with the subject forces one to the realization that other factors must influence the time of appearance of secondary skin deposits.

The two longest lived cases of the main group had radical operations and inadequate x-ray therapy, judged by any stand-

¹ Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13-17, 1937.

the term "epidermitis," which seems rather to connote an inflammatory reaction

Epidermiolysis is very impressive when one sees the skin completely denuded of its surface epithelium, exposing the blood-red corium, but this reaction is, as a matter of fact, quite a harmless one if it is produced by divided doses (*Dosi refracta*). The inflammatory reaction subsides rapidly, and in a few weeks new epithelium invades the zone of reaction from the outside, which epithelium is at first almost free of pigment, later on it becomes pigmented to the extent that in the favorable case complete *restitutio ad integrum* takes place, both in an anatomical and a functional sense. The skin which has been the site of an epidermiolytic reaction responds to external agents exactly as does normal unirradiated skin. This is especially important in regard to operative interferences. In my years of experience I have seen many cases in which, after an epidermiolytic reaction, a biopsy or even some important operative procedure was done without the slightest undue reaction of the skin.

Quite different is the course of events in the development of an epidermiolytic reaction which is produced by a single irradiation with a dose which, in my experience, must be of the order of 2,000 to 2,500 r. The course of the reaction in this case differs in many respects from that produced by divided doses.

From a clinical point of view we notice that the epidermis, instead of being depigmented temporarily, seems to be depigmented permanently, and that the lack of pigmentation is of a high degree.

On histologic examination we see that the newly formed epidermis is composed of fewer cellular layers, and that there is a definite tendency toward the formation of anuclear cornified layers. As a result, the epithelium of the skin is thin and markedly atrophic.

These changes in the skin represent the effect of a severe injury which is most marked in the vascular apparatus and which results in poor nutrition of all the

cutaneous tissues, so that they are functionally subnormal. This fact is drastically illustrated after any operative procedure. Even the slightest biopsy wound may lead to the formation of an ulcer which shows only the slightest tendency to heal. If the dose was excessive the ulcer may have an irrepressible tendency to spread. With even higher doses there results a spontaneous necrosis, which involves the whole irradiated field.

In summary, we find that whereas the epidermiolysis following divided doses is harmless and after it the skin returns to normal in a few weeks, an epidermiolysis following a single dose is a definitely severe and dangerous reaction and one which may easily lead to necrosis of all the irradiated tissues. This difference illustrates very impressively the increased electivity effect of divided irradiation. Whereas the single dose shows only a slight difference in the radiosensitivity of the cutaneous epithelium and the vascular endothelium, with divided doses there is made evident a great difference in their radiosensitivity, inasmuch as a complete destruction of the epidermis can be produced without noteworthy injury to the vessels.

In many cases treated for glandular metastasis I have been able to show that a skin which has been subjected to an epidermiolytic reaction from divided doses can still be subjected to 1,000 r more (in four sessions) without any subsequent necrosis.

From a theoretical and practical standpoint it is of interest to determine whether the changes in the radiosensitivity ratio of the tissues after divided doses can be estimated quantitatively. Since there are individual variations in the reaction to both divided and single doses, the question may be settled by studying the reaction to both in one and the same person. I would like to report a few observations bearing on this point.

A patient with a carcinoma of the epipharynx which had been healed by radium received, on account of bilateral metastasis to the cervical nodes, on the

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doses, the injury-ratio is of about the same magnitude. This fact was shown by Gunsett and by Miescher, who have found not in man but in rabbits it is true, that with fractionating at twenty-four-hour intervals a dose two to three times as high is necessary to produce the effect from a single irradiation.

On the other hand, if one knows the injury-ratio one can estimate the intensity of the single dose needed to produce an effect if one knows the intensity with divided doses. In this we assume a half erythema as the single dose, and one day as the interval between treatments. If, for example, a permanent alopecia of the axilla results from twelve treatments each of 300 r, then one may estimate that a dose of 1,500 r given in one session will produce a permanent alopecia, and that this dose will be constantly followed by telangiectasis but probably not by ulceration. This is a further demonstration that after a single irradiation the effect on the vessels is not so great as after divided doses, but that the effect on the hair follicles is less compromised.

Now the question arises, What tissues act toward divided doses in the same way as did the testicular tissues in Regaud's experiments or the epidermis and the hair follicles in my own observations? Radio-biologic experience has shown that to this category belong the ovarian follicles, the lympho- and hematopoietic tissues, and the sebaceous glands.

What factor is common to all these tissues? They are not, according to the definition of a tissue, made up of one and the same tissue or a single variety of cells, but are made up of different cellular layers anatomically different, and differing in spatial arrangement, and of these tissues the skin is a good example. By their composition from different types of cells these tissues resemble the structure of an organ, or they are, so to speak, of organoid structure. But the individual kinds of cells are not only functionally interdependent as is the case with an organ, but are also genetically interdependent

for one kind of cells produces the others. We designate this kind of cell the *mother cell*. To this group belong the basal cells of the epidermis, the hair follicle, and the sebaceous glands, the spermatogonia, the primary ovarian follicles and the lympho- and the erythroblasts. By progressive transformations and successive stages of greater differentiation these cells finally result in the formation of structures that are either anuclear, such as the horn cells and erythrocytes, or lose their function of mitosis, such as spermatozoa or lymphocytes. All these cells are incapable of independent life and are destined to destruction. In these tissues we can differentiate at least two types of cells: (a) the cells which constantly are in the process of transformation—the *mother* or *germ* cells—and (b) the cells which are no longer capable of living, the *end* or *functioning* cells. In most cases these tissues contain another type, (c), a layer of *intermediate* cells.

Considering their general nomenclature, I would like to propose the term "multi-form tissues," because this term best designates their true properties, since they are made up of many different kinds of cells.

The contrast with the simple *uniform* tissues. These tissues, as the term indicates, consist of one kind of cells, which are generally arranged in one layer, and which exercise some different and specific function. They have no power of regeneration, so that their obliteration is definite, once they are destroyed. The fact must be kept in mind that their destruction produces no physiologic sequelæ. As a rule their death takes place accidentally, usually through the mechanism of damage to vessels which supply them, of which atherosclerotic gangrene, cerebral malacia, or pulmonary infarction are classic examples.


To the group of uniform tissues belong all single-layered epithelial tissues, the endothelial layers of the vessels, and the serous membranes, the cylindrical epithelium of the mucous membranes, as

THE BIOLOGIC BASIS OF THE FRACTIONATED METHOD OF IRRADIATION OF MALIGNANT TUMORS¹

By J BORAK, M D, Vienna, Austria

Chief of the Röntgeninstitute, Hospital of the Israelitischen Kultusgemeinde

(Translated from the German by E T LEDDY, M D, Mayo Clinic, Rochester, Minnesota)

 ON January 15, 1897, Leopold Freund reported to the Wiener Gesellschaft der Aertzte that roentgen rays could be used for therapeutic purposes

Freund's demonstration was of the greatest importance in the start of roentgen therapy, and has remained of great significance for other reasons. Freund used as a method of treatment of his first case, one of epilation for nevus pilosus, the one which, one may say in retrospect, has survived all other technical procedures introduced in the forty years of roentgen therapy.

The point of the procedure was that the patient was irradiated for two hours daily. The duration of the treatment for two hours was due to the low efficiency of the roentgen tubes, or, rather, the tubes that were used for roentgenologic purposes. Modern tubes produce the same roentgen-ray output in a few minutes. The fact that Freund treated his patient *daily* was not due to technical limitations entirely but is a characteristic of the procedure which we nowadays designate as a *fractionated* method of irradiation. The basic characteristic of the divided dose method of treatment is completely summed up in the following statement: "On the eleventh day, while making the child's toilet, the mother pulled out large bunches of hair." With that the first experiment ended.

The dividing of the dose was not done arbitrarily but it was continued up to the point of the onset of the desired radiation effect. For this reason Freund later designated his method "the continuation of small doses to the point of

effectiveness" and thereby clearly stated its characteristics.

Freund's method of treatment is characterized by both the external and the internal aspects of fractionation which regulate the duration of the treatment, and so, the degree of the fractionation. The intensity and the duration of the individual doses depend on the onset of the radiation effect for which one is seeking.

Freund is, therefore, to be regarded not only as the founder of roentgen therapy but also as the originator of the method of treatment which to-day is known as "fractionated irradiation for a long time" (*fraktionierte Langbestrahlung*) or as "long-time-irradiation" (*Langzeitbestrahlung*) (Schinz, Holthusen).

It was not possible to establish a biologic basis for this method of irradiation in these early days of roentgen therapy. It probably was the same as that ruling all conservative practice of medicine, whether it embraces the use of medical or physical media—the use of the agent up to the point of emergence of the desired effect.

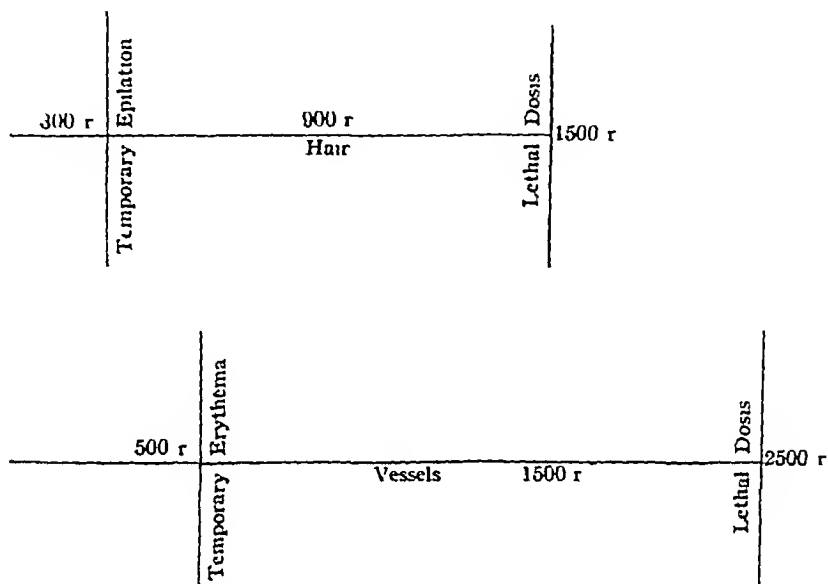
Even though this method of procedure is so well established in both medical and physical therapy that it seems to be almost axiomatic, this same method of procedure in roentgen therapy has developed into one of the most important controversies in the whole roentgenotherapeutic field.

The first comprehensive experimental work on the problem was reported by Friedrich and Kroenig in 1919. These authors irradiated in one sitting one side of the abdomen with a predetermined dose. The other side of the abdomen

¹ Read at the meeting of the Wiener Gesellschaft der Aertzte Jan 15 1937

the multiform than on the uniform tissues. Expressing this in the words of Schwarz, the injury-ratio with divided doses increases in the case of the multiform tissues and decreases in the uniform. In other words, the difference in radiosensi-

partial-effect will either last longer, or return to normal more slowly. It will necessarily cumulate subsequent partial doses better than a weaker one which produces a more transitory effect which rapidly returns to normal.



tivity between the multiform and the uniform tissues increases with fractionated irradiation, whereas the multiform tissues seem more radiosensitive to divided irradiation than to single dose irradiation.

Now the question comes up, What is the cause of this fact that multiform tissues act differently to divided and to single doses than do the uniform tissues? This may be due, in the final analysis, to the fact that multiform tissues have a higher radiosensitivity than the uniform tissues. This fact means only that in the case of the multiform tissues a physically smaller dose is sufficient to damage them lethally, whereas to attain a biologically equivalent effect on the uniform tissues a much greater physical dose must be employed, therefore, to produce a biologically equivalent partial-effect a smaller dose is needed in the multiform tissues than in the uniform. For the same reason equal fractions of a dose will produce in the radiosensitive multiform tissues more intense partial-effects than in the less radiosensitive uniform tissues. A biologically more intense

Let us now look at a concrete example of these relationships (see diagram). Experience has shown that to produce an irreversible damage to the hair, a permanent alopecia, a dose of about 1,500 r, given in one treatment, is necessary. To produce a biologically equivalent effect in the vessels, that is, to produce an irreversible injury which will lead to an ulceration, a dose, if given at one time, of about 2,500 r is necessary. We can assume, therefore, that to produce a biologically equivalent partial-effect on the hair follicle a physically smaller dose, about 300 r, will be necessary, on the vessels, on the contrary, a larger dose, about 500 r. Clinically the former results in a transitory epilation, the latter in a transitory erythema. After a certain time both changes will give place to normal conditions. Now if both tissues receive the same dose, for example, 300 r, there will be a more marked effect produced in the hair follicles than in the vessels. For 300 r means more in the case of the follicles than in the vessels, because 300 r is one-fifth the lethal dose for the hair follicle, and

the single dose method of irradiation there probably has been no procedure in medicine to which so many objections have been raised as were opposed to the single dose technic. Holzkecht, Schinz, and Regaud, followed by numerous students and collaborators, found themselves at the head of an attack against the single dose method, originating in Germany, and which favored the return to and the re-establishment of the divided dose methods of treatment.

Holzkecht's standpoint is particularly worthy of note, because he was an adherent of the theory of concentrated dosage but not exclusively to single dose methods, probably less from biologic than for economic reasons. Urged on by the failures and the injurious by-effects of the single dose method of treating deep seated malignant tumors, Holzkecht, with his characteristic open-mindedness, began to change his old point of view, and became gradually one of the bitterest opponents of the single dose methods. Due to the activities of the Holzkecht school, it was in Vienna that the divided dose method, originating there, had its Renaissance. Gottwald Schwarz gave it further encouragement and support. On the basis of some previous work of his own which showed the dependence of radiosensitivity on the metabolic activity of tissues, Schwarz developed a new theory to combat the alleged superiority of the single dose methods of radiation. The theory is expressed as follows: "It is possible that within the same structure some cell-groups are more sensitive than others, because of different phases of development or metabolism in which they happen to be. We have, at present, no possibility of recognizing that moment which is most favorable for irradiating, yet it seems advisable not to irradiate with single massive doses at long time intervals, which may miss the most favorable period of cell activity, but to employ instead some method of protracted treatment, using relatively small doses daily."

By this was taken the final step in the

return to the radiation methods of Freund. And only the fact that this theory was enunciated in May, 1914, and not published until December, 1914, during the World War, has prevented its due recognition, and in the interval the single dose methods were worked out.

After the war Regaud resumed, in the newly established and now so celebrated Radium Institute in Paris, the problem of the optimal method of radiotherapy. To this end he carried out experiments on animal testicular tissues, which tissues, because of a continuous formation of new cells, are very similar to malignant new-growths. The results of this study were reported in 1922. They culminate in the following: "Just as repeated heating at a relatively low temperature at definite intervals is more effective on spore-bearing organisms than single heating at a high temperature, the tissues, because of their rhythm of division and rest of their cells are more sensitive to repeated irradiation with small doses than they are to a single irradiation with a higher dose."

Schinz and Nather continued Regaud's experiments on mouse carcinomas and came to the following conclusions in 1923: "By repeated irradiations at short intervals we can hit by the rays a greater number of dividing cells than we can by a single intensive irradiation. We are forced to the conclusion that a carcinoma can be made to disappear with roentgen rays, if it be damaged at the time of cellular and nuclear division."

The explanation given by Schwarz shows like a red light through all this fog of developing methods, provided that we adopt the conception of cellular division in the place of his idea of metabolic and morphologic changes. This change goes back to a fundamental piece of work by Holthusen, who, in 1921, showed in the case of *Ascaris* eggs that the cells at various stages of development vary in their radiosensitivity, and that they reach their highest degree of radiosensitivity during their mitotic stage.

To what extent it is correct to substitute

fractionation may be more or less effective in the constitutionally radioresistant tumors, depending on the proportion of radio-sensitive elements they contain. The fundamental make-up of a tumor of necessity sets the limit to the increase of electivity of the radiation effect possible by dividing the dose. It is evident that fractionation is no radiotherapeutic panacea. The radiobiologic activity of a tissue, and the tumors derived from it, determine the effectiveness of any radiation technic by which it is treated.

These are the basic facts of divided dose treatment, as first established by Freund, theoretically explained by Schwarz, experimentally certified by Regaud, and worked out practically by Coutard.

Now the Coutard method, regarded from a historic point of view, is nothing more than the method of Freund adopted to special aspects of particular tumors, and a modernization of his ideas as a result of the accumulation of experience and experimentation in the intervening years. *The fundamental theory, the continuation of small doses up to the point of the onset of the desired effect, remains unchanged.*

We see from all this that it is not right to designate the divided dose method as one of weak irradiation in contrast to methods of intensive irradiation, for in the case of fractionated irradiation only the individual doses are small and weak, the total dose may be very high, in fact, much higher than those of the so-called intensive methods. We must keep in mind that low and intensive doses are only relative terms, and that the very same dose from the standpoint of a carcinoma may be regarded as very small and from the standpoint of an inflammation, very high. One cannot say therefore, that in the case of divided dose treatment no severe tissue reactions take place, for it is generally known that with the Coutard technic very definite reactions are produced, such as were previously unknown, or, at least, were not common. Nor is it correct to regard the divided dose method as a poor way to carry out treatment now, that dosimeters

are available for measuring the effect of treatment. As a matter of fact, Holzknecht had a dosimeter in 1902. We know that since accurate dosimeters are universally available we can measure the dose necessary to produce any effect, and it is no longer necessary to continue irradiation with small doses up to the point of the onset of the desired effect, as was necessary before there were dosimeters available. In these days it is clear that the question whether the individual dose can be measured or not has nothing to do with the biologic foundation of divided dosage, because it is possible when a divided dose technic is used to measure the individual doses very accurately, such as, for example, with the Mekapion of Strauss.

It is beside the question whether we designate the fractionated method as the original and contrast it with expeditive methods of irradiation. We know that we can irradiate with divided doses, in other words proceed expeditively, as is so often the case nowadays, but still even if we do not irradiate in a single session we are constrained to limit the irradiation to a definitely spaced serial treatment.

It is correct, nevertheless, to regard fractionating as the original method of radiologic treatment, for it was, and still is, the fundamental method in radiotherapeutic procedures. As a result of this, radiotherapy has become one of the most important methods of treatment in the whole field of medicine, due to the inspiration of Freund, forty years ago.

BIBLIOGRAPHY

- BORAK J. Strahlentherapie 1932 34
 FREUND. Wien med Wchnschr 1936 34, Strahlentherapie, 1928 27
 FRIEDRICH and KROENIG. Strahlentherapie (Ergebn) 1919
 GUNSBITT. Riv di Radiol 1931 5
 HOLTHUSEN. Strahlentherapie 1931 41
 LIECHTI. Strahlentherapie 1929 33
 MIESCHER. Acta Radiologica 1934 16
 NATHER and SCHINZ. Grenzgeb d in Med u Chirurg, 1923, 36
 REGAUD. Compt. rend soc de biol, 1922, Acta Radiologica, 1930 11
 REISNER. Ergebn. d. med Strahlenforsch 1933, 6 1-80
 SEITZ and WINTZ. Unsere Methode der Röntgen-tiefentherapie, 1920
 SCHWARZ. München. med Wchnschr 1914 23
 Strahlentherapie, 1924 18, and 1925 19

the spermatogenic epithelium. He found that the smallest dose which could accomplish this end could not be tolerated by the surrounding tissues, but that it produced a severe necrosis of the neighboring skin and the rectal mucous membrane. But if Regaud divided the dose into a period of two weeks then the total dose had to be increased from 4,000 r to 6,000 r, but there then resulted a permanent sterilization, but without skin necrosis.

This emphasizes the point that with fractionated irradiation the radiosensitivity ratio between skin and testicular tissues is changed, that in this case testicular tissue has become more radiosensitive than it was in the case of a single irradiation. We see that with the use of divided doses it is possible to produce complete destruction of the testicular tissues without injuring the skin. With a single dose this effect is possible only at the price of a necrosis of the skin. The effect on the spermatogenic epithelium when the divided dose method is used, has (to again use the words of Schwarz), in fact, become more elective.

Now, if we imagine we are dealing with malignant epithelium rather than with testicular epithelium, the results of these experiments will have a practical significance, for they indicate that a neoplasm which cannot be obliterated by a single dose that will spare normal tissues, by means of fractionated irradiation may be made to disappear without injury to the normal surrounding tissues.

Regaud's researches have not only established the theory of Schwarz of the *dissociated radiation effect* on solid ground, but have also cast much light on the relationships of normal to pathologic tissues, which he suppressed in his theory. For Regaud experimented on normal tissues and found in their case the same contradictions which Schwarz found in the case of tumor and normal tissues. This relationship must be regarded as a special case of a much more general relationship.

This relationship in man can best be studied in the skin, for the skin is the organ

which is most often irradiated in a variety of ways. The changes in the skin subsequent to irradiation can be followed in detail, and can even be photographed. The changes in the skin can also be easily followed histologically by the study of suitable biopsy specimens. From these we derive the decisive fact that the skin is composed of a variety of tissues, and that it may serve as perhaps the best object in the study of the differences in reactivity of various tissues to a single and a fractionated method of irradiation. Bearing on this point is the following observation.

A woman received on the left side of the abdomen, including the mons pubis, 800 r, filtered through 0.5 mm zinc, in a single treatment while the right half of the abdominal wall received two treatments each of 400 r at a twenty-four-hour interval. We can see that whereas the side treated with the single dose reacted with a marked erythema with subsequent pigmentation, the changes on the side given divided doses are very mild. Nevertheless, there is complete epilation on both sides. We also can observe that *hair* and *blood vessels* react quite differently to division of the same dose. Whereas the division of the dose into two days showed no difference of effect in the case of the hair, the division plays a great rôle in the case of the skin blood vessels, for here there is a definitely weaker erythema than where a single dose was given.

Even more instructive are the differences of reaction to single and divided doses if we compare conditions in the *epidermis* and in the *vessels*. If we irradiate in divided doses giving at twenty-four-hour intervals 250 r in eighteen consecutive treatments, a total dose of 4,500 r, there follows a complete disappearance of the epidermis. Regaud has proposed the term "epidermitis" for this effect. I prefer, however, the term "epidermiolysis," because it seems to me to describe the radiation effect—the disappearance of the epidermis—more accurately than

one cannot escape the necessity of studying capillary activity in normal tissue and under various abnormal conditions, especially in case one is considering the early phases of inflammation. Krogh (1) has furnished us with rather elaborate descriptions of such investigations, and has demonstrated intrinsic contractility in the ultimate cells of capillaries, the so-called Rouget cells. Clark (2) seems to differ on the separate contractility of such cells, unless they have already received their nerve supply. The nervous mechanism has been traced to both sympathetic and para-sympathetic nerve supply (3), the sympathetic being chiefly concerned in contractility while the para-sympathetic nerve supply is principally involved in dilatation, although the action may be mixed. Reflex phenomena through other nervous paths are unquestioned and are most important in the consideration of our problems. Psychic and emotional influences may involuntarily influence the mechanism of our vascular system. Cannon (4) has demonstrated the relationship between the mid-brain and many of our reflex phenomena, and the close relationship of many autonomic nervous activities with our higher nerve centers. He prefers to link up many of these activities with the adrenal and other glandular secretions. The close inter-linking of various divisions of the autonomic nervous system must not be lost sight of. For example, many of our gastro-intestinal symptoms associated with gall-bladder disease cannot be explained on the basis of anything but overflow nerve impulses or reflex influences. In other words, we all know a local reaction may be the result of a distant stimulus and may be quite intense.

The nature of the local reaction may be intense or mild, and quite a few factors are responsible, as stated above. In the final analysis the reactivity of the individual is a most important consideration. The reactivity depends on a number of things, some of which may vary in individual cases or under different influences. An individual suffering from one ailment may re-

spond more intensely or less intensely to a superimposed infection. An infection may confer immunity to a greater or lesser degree for any subsequent reinfection. Then again, an infection may cause a most intense reaction about any reinfection, and is said, therefore, to produce a hypersensitivity. The literature has been flooded with attempts to explain the nature of this so-called "allergy" (5). Tuberculous infection probably offers us our best example of variation in infectious allergy. Eczema, urticaria, angioneurotic edema, pollen sensitivity, infectious allergy, and food allergy are all fundamentally similar. There are quite a number of other conditions which also come under the caption of allergy. When one tries to analyze the similarities in these conditions one feature stands out—the interference with the normal circulation of the part said to be allergic. Just to what degree the lymphatics, which are primarily afferent vessels, participate, is not entirely clear, but the capillary blood supply is probably the main source of our tissue reaction. While it is possible that a direct chemical influence on the capillary walls may be partly responsible, there is much evidence that the nervous mechanism in control of the vascular supply is perhaps more essential in the production of such exudates. Hypersensitivity is at least partly and perhaps entirely a result of a sensitized autonomic nervous system. Stimulation of the sympathetics may result in blanching of the part or in marked congestion. The mechanism of so-called "sensitization" still remains unsolved. More and more conditions are being considered under the subject of allergy and it becomes apparent that a large number of reactions cannot be explained on the basis of a sensitizing substance which develops and perfuses the entire body. Some of the conditions we shall describe can have nothing but a nerve connection between the exciting cause and the ultimate effect. Whether one can still explain local tissue swellings (6) on the basis of a local production of a histamine-like substance (Lewis' H-substance) and its effect on the local

left side 2,000 r in a single dose, and on the right side 4,500 r in eighteen treatments, each of 250 r. The distance on both sides was 35 cm and the filtration was 0.5 mm zinc. A severe epidermolysis appeared on both sides at about the same time, but there resulted a greater injury to the vascular system on the side given the single dose. It was noticeable that the epidermolysis healed more rapidly on the side which had had divided doses, in spite of the fact that on this side two biopsies were made. The epidermolysis on the side with the single dose did not heal any more rapidly in spite of the fact that on it no operative procedure was carried out, and the newly formed epidermis remained depigmented for a much longer time.

I wish to cite another case. A woman received (because of lenticular metastasis in the left thoracic wall) a dose of 2,000 r in a single dose, and in the opposite side of the thorax received a total dose of 5,400 r in eighteen sessions, each of 300 r through small fields. The filter was 1 mm Al, the distance 25 cm. An epidermolytic reaction was about equal on both sides, and both healed up in about the same time. However, as a result of the excessive dosage in the field which received the single dose there resulted after some insignificant trauma an ulcer which showed slight tendency to heal, while the side which received the divided doses showed not the slightest sign of a tendency to ulceration after a period of observation of one and a half years.

The next case illustrates that after excessive fractionated irradiation more severe reactions may take place than after a single dose. A patient with advanced nodular metastasis after a laryngectomy received on the left side of the neck 2,000 r in a single dose, and on the right side 5,000 r in twenty treatments. The filter was 0.5 mm zinc and the distance 40 cm. No epidermolysis resulted on either side, but only a marked desquamation which apparently returned to normal. Now, four years after treatment, there are more

telangiectases on the side which received the divided doses.

One can see, therefore, that there are individual variations in the radiosensitivity ratios, but that one is probably correct in assuming that *if one gives not more than 300 r per dose*, or, in other words, gives about a half of that quantity of radiation which used to be called a skin erythema dose, and *if there is an interval of twenty-four hours between treatments*, under the usual conditions of dividing the dose it is possible to give at least two and generally two and a half times as high a dose as can be given in one treatment. A dose three and a half times as high under the conditions mentioned, even with divided doses, will probably produce ulceration.

I might add that I have shown that the lethal dose for the epidermis if given in one treatment is 2,000 r, whereas previously it had been assumed that it was about 600 r if given at one time, and resulted in erythema reaction. Since the epidermolytic reaction after a single dose is about three and two-tenths times as high as an erythema dose, and since with divided doses of 300 r per day and one-day intervals it is possible to give about two and one-half times the epidermolytic dose, it is possible to give nowadays to each treatment field a dose which is about eight times the dose which had formerly been assumed to be maximal, if given in one treatment. But here we must keep in mind the fact that we are comparing very dissimilar reactions, not the effect of the single and the divided dose, but a simple erythema reaction on the one hand and a complete epidermolysis on the other. If one considers only the epidermolytic reaction, then he finds from the observations I have just cited that in the case of divided doses it takes about two and one-half times as high a dose to produce an equal effect in the epidermis without definite changes in the blood vessels and connective tissues.

In the case of the hair follicles and the vessels, considering both single and divided

numberable closed fibrous-walled cells. Every other organ contains fibrous divisions and septa which are not quickly expansile. It is questionable whether the brain requires quite the same congestion pressure to produce necrosis, although we do have sufficiently tough septa to prevent undue spread of the pressure effects from infection in brain abscess. In osteomyelitis, infection passing into the marrow by way of the nutrient foramen quickly involves the bone marrow, and the spread of pressure effects results in asphyxia when the intra-medullary pressure equals the systolic pressure of the nutrient artery. Bone lymphatics in such conditions as Garré's disease may become chronically infected without the violent reactions one finds in osteomyelitis. Syphilis and other diseases may act similarly. In young children in whom the marrow cavity is smaller and the epiphyseal arteries are of greater importance, these arteries are more often the source of bone infection. In these cases the infection may not reach the marrow cavity and only localized bone abscesses may result, which may discharge externally without reaching the marrow. If the marrow becomes thoroughly invaded by infection and reaction, the entire diaphysis must necessarily become necrotic, unless the pressure has been relieved surgically or by discharge of the pus, before sufficient time has elapsed to thoroughly asphyxiate the bone cells. We are quite certain that early diagnosis of osteomyelitis, and surgical relief of developing intra-medullary pressure, will limit the amount of bone destruction, in spite of the danger some believe to be present from dissemination of infection in too early surgery. We all know that compound fractures generally do not result in osteomyelitis, unless the marrow cavity closes through callus formation, which now produces conditions suitable for increased intramedullary pressure. There is a great difference between osteomyelitis and bone infection, although the resulting bone necrosis follows a somewhat similar course.

It is my belief that, regardless of what

the x-ray will show in the way of bone absorption in osteomyelitis, any subsequent evidence of more bone destruction is merely the manifestation of tissue damage resulting from the inflammatory reaction at its height. In other words, bone killed but not absorbed, or bone damage beyond repair, will subsequently absorb to produce the impression of advancing infection. Likewise it is my contention that tuberculous cavitation may show cavities of increasing size, but that the cavities are again predetermined in size by the degree of tissue reaction and local pressure effects, at the height of our so-called allergic reaction. The peeling off and absorption of material from the wall of the tuberculous cavity again is confined almost entirely to tissue damage by the initial reaction. Thrombosis of wall vessels with resulting vascular insufficiency may possibly add a little to the process. Closure of the outlet of a cavity might mechanically stretch and enlarge an existing cavity through pressure from exudates accumulating within the cavity. The tendency is, of course, to cavity shrinkage, through scar retraction, and, as some believe, to outlet closure with subsequent absorption of the contained air causing cavity collapse. New cavitations are not extensions but new infection implantations on virgin tissue with extreme sensitivity and good vascularity and, therefore, intense reactions. Reactivation of old lesions is rarely so intense. Large cavitations almost invariably occur with highly allergic reactions, and one may anticipate these cavities by picking out the most dense, most highly exudative areas in our x-ray films. The degree of allergy present is not always apparent in our lung plate as a subsiding lesion with very little exudate may be accompanied by an increasing hypersensitivity which might prove really dangerous only if new implantation occurs. The Mantoux skin test should be of prognostic significance and a guide to treatment. As allergy subsides with time, so would the danger from cavitation subside until reinfection restimulated the patient's hypersensitivity. I am certain that with

well as exocrine and endocrine glands. To this group belong, further, the spindle-celled connective tissue elements, and all tissues derived from connective tissue, bone and cartilage, muscular and nervous tissue.

MULTIFORM TISSUES

Ovarian follicle
Spermatogenic testicular epithelium
Lymphopoietic system
Hematopoietic system
Hair follicle
Sebaceous glands
Epidermis
Basal epithelium

The difference between the two types of tissues does not agree, as can be seen in the foregoing table, with the difference between epithelial and mesenchymal tissues, nor with the difference in their origin from various germ layers.

The differences in the two types of tissue lie not only in their anatomic structure but also in their reactions to radiation. The *multiform* tissues as exemplified by the spermatogenic epithelium of the testis or the epidermis are *more radiosensitive than the vessels* and can be electively destroyed, therefore, by radiation. The destroyed cells are resorbed. This process either proceeds without any reaction, as is the case with lymphatic cells or germ cells, or it gives rise at most to only transitory inflammatory phenomena, such as can be observed in the basal cells of the skin and mucous membranes.

On the contrary, the *uniform tissues* as exemplified by the sweat glands or the spindle-cell connective tissue elements are *less radiosensitive than the vessels*. They cannot be made to disappear primarily (*electively*) but only secondarily (*nutritively*) and indirectly through injury to the vascular endothelium, with secondary endarteritis. As a result of this process the dead cells are sloughed, with the ensuing clinical picture of a sequestration or gangrene of the irradiated tissues.

The pictures of a roentgen-epilated skin, on the one hand, and an ulcerated skin, on the other, emphasize the different radiosensitivity of the two types of tissues, and

the different mechanism of their destruction which depends on it.

The low radiosensitivity which is associated with the permanency of the uniform tissues is of great radiologic importance, because of their vital function

UNIFORM TISSUES

Endothelium of the vessels
Endothelium of the serous membranes
Spindle-celled connective tissue elements
Fixed connective tissue and glia
Osseous and cartilaginous tissue
Muscle tissue
Nerve tissue
Cylindric epithelium

and because they are irreplaceable anatomically, and therefore the conception of a therapeutic dose means that quantity of roentgen rays which produces no necrosis in the vessels or in the uniform tissues. Higher quantities of radiation which produce necrosis of the uniform tissues have, as such, no place in radiotherapy. They are to be regarded not as radio-physiological, but rather as radio-pathologic.

Radiotherapy, therefore, has a particular interest in sparing these tissues.

It seems to be a fact of the greatest importance that divided dose technics are the best way to accomplish this end. It is evident that *the multiform and the uniform tissues do not react in the same way to single and divided doses*. Fractionating results in a less decrease of effect in the *polyform tissues* than in the *uniform tissues*. Regaud showed this in the case of spermatogenic testicular epithelium. I have referred to my own observations on the behavior of the epidermis and the hair, and have referred to analogous experiments of Miescher and Gunsett on the hair follicles. We could bring in analogous data on the other polyform tissues, but let it suffice for the present to point out the professional injuries sustained by radiologists. Injury of the hematopoietic and the lymphopoietic systems and the genital glands resulted from the summation of very small doses, without any recognizable injury of the skin or pathologic changes in other tissues. Fractionating, therefore, exerts a much stronger effect on

and capillaries of toxic products depends to a great extent on this driving pressure.

Most tissue reactions, even in the highly allergic, are self-limited, with the time limit varying with each type of infection and its intensity and complicating factors. The development of pressure equal to or greater than arterial pressure should necessitate some speculation regarding its production. The permeability of damaged capillaries has been frequently described. Other factors, however, probably enter to help the production of these exudates. Electrolytic changes with acidulation of tissue from oxygen lack probably have much to do with the increased vascular permeability, through capillary damage. Whether or not these changes, which must necessarily produce only slight increases in the pH of the tissue, result in the greater fixation of fluid in those tissues through accumulation of electrolytic metabolites would be difficult to prove. Martin Fischer (10), by demonstrating the increased water-absorbing power of either acidulated or alkalinized gelatin, was convinced that edema was merely a matter of tissue pH. Osmosis and diffusion depend greatly, however, on other factors. There is probably a combination of factors entering into the production of extreme pressure exudates, which only time can explain adequately.

Again, we know that in closed bony cavities, sinuses, and long bones, we may produce marked necrosis of bone without much possibility of fluid entering from any source after the local blood supply is blocked. It has been shown by Brooks (11) that in osteomyelitis the intra-medullary pressure must be equal to the arterial systolic pressure before osteomyelitis can develop. It has long been my contention that dental apical abscesses, as seen in x-ray films, are the result of asphyxiation necrosis. At the height of these reactions the x-ray may show nothing except possibly evidence of a thickened pericemental membrane from congestion. The ragged radiolucent shadow ordinarily called the abscess is merely due to the absorption of bone damaged beyond repair by pressure

effects at the height of the reaction. This absorption takes place in the same way that any other dead bone would be absorbed, through osteolytic ferment activity (12). We do not find these periapical absorption areas where the conditions do not allow the local accumulation of reaction products and pressure effects. If the dental root canal allows sufficient drainage to prevent local pressure effects, we do not see bone absorption. When the dental canal is closed in such cases by dentistry or otherwise, an intense reaction may follow, with marked swelling of the face, indicating that the infection has perforated the alveolar plate. Even now the radiograph may show very little of the usual evidence of periapical bone absorption at any stage of the infection, because of the drainage of inflammatory products into soft tissue. It should be apparent that here also, pressure effects must account for bone necrosis.

I wish briefly to discuss my concept of gastro-intestinal ulceration. As stated above, the effects produced in tissue destruction are the result of asphyxiation, and the autonomic nervous mechanism (so-called sympathetic and para-sympathetic nervous system) is probably the underlying factor in producing the vascular response that produces the asphyxia. It would be well to mention that it takes an irritant like bacterial infection to produce many of the results of tissue necrosis such as we see in abscess formation. Somewhat different factors are found in sterile asphyxiation of tissue, as I believe most of our peptic ulcers to be in the early stages. While it is true that we may have ulceration, produced by gastric syphilis and a number of other conditions, where the process is gradual, with slowly produced vascular insufficiency which may result in local tissue death, such processes, I do not believe, are the ones followed in our ordinary gastric and duodenal ulcers. When one considers the total lack of proof one cannot but consider this as anything more than a rather bold assertion of what may look like facts. After seeing a number of allergic individuals who, following

only one-eighth the lethal dose for the vascular endothelium. A dose of 300 r will probably produce a temporary epilation but probably no demonstrable erythema. The stronger effect in the hair follicles will naturally be more difficultly reversible, and therefore last longer than the weaker, more easily reversible, and briefer effect on the vessels. If, after an interval, we apply 300 r again, then the biologic effect of the first irradiation will be still evident in the case of the hair follicles, or may even be emphasized, whereas in the vessels the reaction will have subsided or will be intensified only a little. As a result of this the second partial-dose will injure the hair follicle more than it will the vessels, or, from another point of view, dividing the dose spares the vessels more than the hair follicles.

The fact that divided dosage is relatively more effective on the multiform than on the uniform tissues depends also on the different capabilities for cumulation of these two tissues, which fact is based on the different radiosensitivity of the two types of tissue. In general we can say that the higher the radiosensitivity the smaller are the doses which can cumulate, the less radiosensitive a tissue, the less its capability for cumulation, and the greater must the doses be for the production of biologically equivalent partial-effects.

So far, we have compared the relationships of normal tissues to each other. In regard to tumors, I wish to point to the theory which I have developed, according to which tumors do not behave fundamentally differently toward radiation than do the mother cells from which they are derived. I have given evidence for this point of view elsewhere (1932). With reference to this question I would like to repeat it again and add that radiobiologic experience and the literature, both, add new substantiation of the correctness of this conception. We can sketch it briefly as follows: it happens that in some tumors there are a great number of elements that are more radiosensitive than their mother cells and, therefore, can be made to disappear without injuring them. Other tumors

contain a varyingly great number of elements, the radiosensitivity of which is the same order as that of the mother cells, and, therefore, they cannot be made to disappear without destruction of the mother cells.

Therefore, we may differentiate two types of tumors. To the first belong those tumors which are made up of polyform tissues. We can classify them as *constitutionally radiosensitive*, because they are made up of tissues which can be made to disappear completely without injury to the vessels. To the second type belong those tumors which are derived from uniform tissues. We may classify them as *constitutionally radioresistant*, because they may be made to disappear only at the price of a vascular necrosis, or else they may be made to decrease in size to an indefinite extent.

Lymphosarcomas, seminomas, granulosa-cell tumors, tricho-epitheliomas, and the basal-cell carcinomas of the skin and mucous membranes are in the group of constitutionally radiosensitive tumors. Adenocarcinomas, most sarcomas, and most gliomas belong to the group of the constitutionally radioresistant tumors.

In the case of the constitutionally radiosensitive tumors it is possible to continue divided treatments to the point of the desired radiation effect, that is, up to the point of disappearance of the tumor. But in the case of the constitutionally radioresistant tumors only a formal fractionation is possible because there is no normal to base the height of the total dose on or the degree to which the dose should be fractionated, the goal of irradiation, the disappearance of the tumor after irradiation, is not possible to achieve with radiotherapeutic methods. It is in this group of constitutionally radioresistant tumors that divided doses manifest their greatest value. For there is in this group of tumors a more or less large number of elements which are of a greater radiosensitivity than their mother cells, and on which fractionation is the more effective the more radiosensitive the tissue is, and, therefore,

the proximal colon, when seen under the fluoroscope after a barium meal, presented a lumen reduced to the size of a knitting needle, and the colon was hard and ropery to the touch. Subsequent x-ray examination did not show the extreme colon spasm. The gall bladder was normal. Such findings are not unusual, and under such circumstances must be considered as hypersensitivity reactions. We should proceed with caution in discarding the time-honored explanations of events in gastric and duodenal ulcer formation, but I see no reason why many of the so-called causes cannot be more easily explained as the results of ulceration. Our ideas are changing also in other directions. So-called acute glomerulonephritis is held by many to be a manifestation of kidney sensitization (vascular sympathetics). A recent case that I had the opportunity to follow proved most interesting. Sensitization of the kidney parenchyma (other organs probably also became sensitized although this was not so apparent) occurred following measles, although there was nothing to indicate this at the time. An acute mastoiditis developed at a later date, whereupon the patient became edematous, pale, and poured out much urinary albumin. Because of the patient's bad condition x-ray mastoid therapy was advocated. A temporary clearing of the mastoid, following good drainage and clearing as seen by x-ray examination, resulted in almost complete remission of all the symptoms and urinary findings. After a week, with subsiding discharge, closure of the outlet in the eardrum resulted in a recurring mastoiditis and immediate recurrence of all the nephritic findings. Drainage was soon re-established, with again, prompt disappearance of symptoms and urinary albumin. This all occurred within a period of three weeks. It is not the rule for so-called acute nephritis to develop with mastoiditis, and sensitization appeared to be a preliminary essential for its production here. Tenosynovitis, bursitis, arthritis, and other conditions during acute ex-

acerbation stages can often be best explained on an allergic basis.

DISCUSSION

After perusing the above, certain points stand out as needing further discussion. Assuming that anoxemia is our primary cause of cell death, it becomes a rather difficult matter to prove the events which actually take place in its production. Thrombosis of blood vessels is always present in abscess, but should it be considered a late result of necrosis or the cause of asphyxiation necrosis? Osteomyelitis often quickly produces in the early stages very high intra-medullary pressure and vascular stagnation, without thrombosis of the vascular supply of the bone marrow (except for the thrombosis developed at the site of the infecting embolus) as evidenced by the quick recovery and absence of bone necrosis when early surgery is instituted. Thrombosis of vessels must at least be a late event and occur after asphyxiation has begun. In dental apical abscesses mere infection does not produce bone necrosis. The infection must be in a sealed bone area, as no abscess develops when the inflammatory products can escape. Moreover a vascular supply is necessary for the production of inflammatory pressures. Vasoconstriction may precede the dilative exudative phase of the allergic reaction. In surface exudates, like the allergic exudative tuberculous pleural effusions, there is no chance of pressures becoming great enough for necrosis, and we also see no thrombosis. The fibrous lung lobule forms a resistant sac when the bronchiole closes from inflammatory reaction. One can easily show this by noting how little, if any, expansion takes place when a lung lobule attached to a tube is dilated with increasing pressure after the lung lobule has once become distended. Again, infection is not a necessary accompaniment of all so-called allergic necrosis as we see in peptic ulcer.

The relationship between cellular exudates and the hypersensitivity reactions

only one-eighth the lethal dose for the vascular endothelium. A dose of 300 r will probably produce a temporary epilation but probably no demonstrable erythema. The stronger effect in the hair follicles will naturally be more difficultly reversible, and therefore last longer than the weaker, more easily reversible, and briefer effect on the vessels. If, after an interval, we apply 300 r again, then the biologic effect of the first irradiation will be still evident in the case of the hair follicles, or may even be emphasized, whereas in the vessels the reaction will have subsided or will be intensified only a little. As a result of this the second partial-dose will injure the hair follicle more than it will the vessels, or, from another point of view, dividing the dose spares the vessels more than the hair follicles.

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may temporarily divert the reader's attention from the main issues. The subject, as presented, is quite new to many, and for that reason must necessarily cover much ground, which can be given only cursory treatment in such a short paper. It should also be well understood that the above ideas are presented for consideration merely.

BIBLIOGRAPHY

- (1) KROGH, AUGUST. The Anatomy and Physiology of Capillaries. Yale Univ. Press, 1930.
- (2) CLARK, ELIOT R. Growth and Development in Blood Vessels and Lymphatics. Ann Int Med, February, 1936, 9, 1043-1049.
- (3) KUNTZ, ALBERT. The Autonomic Nervous System. Lea & Febiger, 1934.
- (4) CANNON, W B, and DE LA PAZ. Emotional Stimulation of Adrenal Secretion. Am Jour Physiol, 28, 64-70.

- CANNON, W B. Recent Studies on Chemical Mediation of Nerve Impulses. Endocrinology, 15.
- (5) ROWE, ALBERT H. Clinical Allergy. Lea & Febiger, 1937.
- (6) LEWIS, T, and GRANT, R T. Vascular Reactions of Skin. Heart, May 1924, 11, 209-265.
- LEWIS and HARMER. Further Evidence etc. Heart 1927, 14, 19-26.
- (7) SCHNACK, A G. Roentgenography in Prognosis of Pulmonary Tuberculosis. Am Jour Roentgenol and Rad Ther 1927, 453-457.
- (8) KRAUSE, ALLEN K. The Evolution of the Tubercle. Jour Outdoor Life New York, 1926.
- (9) JÖDLING. Arch Int Med about 1912.
- (10) FISCHER, MARTIN. Edema and Nephritis.
- (11) BROOKS, BARNEY. Personal communication.
- (12) SCHNACK, A G. Dental Infection. Jour Am Dental Assn, November, 1933, 20, 2039-2045.
- (13) CORVILLOS, P N, and BIRNBAUM, GEORGE L. Bronchial Obstruction. Am Jour Roentgenol and Rad Ther, November 1929, 22, 401-430.
- (14) SCHNACK, A G. Pneumonia Roentgenologically Considered. RADIOLOGY, September 1932, 19, 177.
- (15) CUSHING, HARVEY. Peptic Ulcers and the Inter brain. Surg Gynec and Obst, July, 1932, 55, 1-34.

TISSUE NECROSIS

By A G SCHNACK, M D , *Honolulu, T H*

WITH the advent of new ideas and discoveries older theories gradually need revision as they become inadequate. Any departure from previous concepts should not be proffered in a spirit of dogmatism and should be most critically considered before being incorporated into even a working hypothesis. It is with this attitude that I wish to present a number of, what I think to be, concepts which differ in part from existing ideas in the study of underlying events in the production of necrosis in the living organism. There are so many phases of this problem that it will be impossible in such an abbreviated treatise to cover many of the controversial points, and again no single individual can be so imbued with knowledge as to adequately explain all the different phenomena in proper terms of chemistry, biology, physiology, and experimental and clinical data. It will be necessary, therefore, in great measure to depend on facts and opinions already presented by others. A number of dogmatic ideas must necessarily be presented without the proof of personal experiment, especially as it would require methods which will still have to be developed. Opinions here presented are the result of long consideration of what were thought to be better explanations of events, arrived at from copious laboratory, pathological, roentgenological, and clinical observations. Roentgenological findings, perhaps, offer much more important contributions in pathological diagnosis than is ordinarily thought, as changing events can often be much more conveniently followed roentgenographically than in the pathological laboratory.

I doubt that any two pathologists would quite agree on what really constitutes "tissue necrosis," even though the description of the gross and microscopic events of necrosis might be adequately described.

In the consideration of this subject the

vast field of immunity must necessarily enter. Antibodies, opsonines, agglutinins, inflammatory reactions, allergy and all that it implies, all contribute to the process we wish to describe.

In the discussion of tissue necrosis it is not my intention to describe the slow replacements such as we see in liver cirrhosis, secondary contracted kidney, etc., where the real functioning elements gradually degenerate and disappear under the influence of long-standing insults of numerous sorts. An entire organism or individual organs may suddenly cease to function, but such events do not constitute necrosis. Caustics may quickly destroy tissue as do other agents like extreme heat, chemicals, electricity, radiation, etc., but we shall not consider such in this paper. Neither shall this paper be concerned with the results of low-grade inflammatory reactions, where tissue destruction is a slow process varying in each case with variable and slowly changing conditions.

We shall begin by considering acute inflammatory processes. First, we have our irritant which may be one of many kinds we prefer for simplicity to assume a bacterial irritant. The response varies according to the type of invading organism and the reactivity of the host, both of which may show great variation. The cellular response is a very important factor and again varies with the host and the invading organism. However, it is my belief that too much emphasis is placed on segregating different infections according to the offending organism, although we must recognize that the course of events must necessarily depend upon the nature of the invader. Nevertheless, infections all have a certain similarity regardless of such differences, and the general consideration of infection leads often to a better understanding of what is taking place.

In the study of inflammatory processes

method of investigation have been made. In addition, there are many other reports of individual cases and studies of individual variations. The latter are illustrated by the papers of Buschke (2, 3) and Haffner (7). The complete literature is far too voluminous for further consideration and has already been well reviewed in the various articles cited above.

The hereditary nature of the tendency to bear multiple children has been clearly established by numerous investigators. The opinions on this matter are summarized by Buschke (3, 4). He also discusses in some detail the manner in which twins and triplets chance to occur. While the mechanism in man is not positively established, the theories are reasonably well supported by factual evidence. For purposes of clarity, it may be well to describe briefly the possible means by which various types of multiple births may take place. Fertilization by two separate spermatozoa of two simultaneously appearing ova, from one or both ovaries, will result in dissimilar or non-identical twins. Likewise non-identical twins may occur from the fertilization of one ovum which then divides, the daughter cell being fertilized by another spermatozoon. Identical twins are the result of the fertilization of one ovum by one spermatozoon, as the cell divides, the first two products separate completely, two distinct fertilized ova being produced. The twins from such an ovum partake equally of the chromosomes of both parents and are, therefore, identical.

The occurrence of triplets is a more complex process. Two ova may be fertilized by two spermatozoa. One of these may then divide, with identical twins resulting, while the other ovum goes on to normal development. The product would be dizygotic triplets, two of the set being identical, one, non-identical. It is possible for both fertilized ova to divide and for one of the four products to fail of maturity, the final result will be the same as above. Fertilization of three ova by three different spermatozoa would,

of course, result in trizygotic triplets, all non-identical. A similar result might occur if one ovum was fertilized, divided unequally the daughter cell then being fertilized again, while simultaneously another ovum was fertilized by a third spermatozoon. While it has never been positively established in man, it seems reasonable to assume that identical triplets originate from one ovum, fertilized by one spermatozoon. This proceeds to divide, first into two and then into four cells, all of which develop separately but have the same chromosomal constituency. From this would come uniovular quadruplets. If, however, one of these cells fails to mature, three embryos of exactly the same heritage would remain, a set of monozygotic triplets. While these are rare, they undoubtedly occur.

It is evident that in twins we may see identical, partially identical, and non-identical pairs. The latter two are considered together as dizygotic twins. Amongst triplets there may be monozygotic identical sets, dizygotic sets, composed of one pair of identical twins and one odd member, and trizygotic sets in which all the members are non-identical.

Roentgen examination of the anatomy of twins and triplets may, in many cases, constitute a great aid in determining their mono-, di-, or trizygotic origin. Striking similarities in the rate of development of the skeletal structure, in the form, size, and position of the ossification centers, in the form, size, and development of the paranasal sinuses and mastoids, in the size and shape of the heart, and in the presence of anatomical variations all serve to indicate the uniovular origin of multiple birth siblings. In addition to this, in those cases in which the monozygotic origin of twins and triplets has been conclusively established by other evidence, roentgen studies may give valuable information as to the hereditary or acquired character of certain anomalies and anatomical variations such as the anomalous lobes of the lung, defects in the vertebral

capillary wall, offers much room for argument. Most tissue swellings seem to show a direct relationship between the filtration pressure of capillaries and the osmotic pressure of the capillary blood, which depends, for the most part, upon the non-filterable colloids (1)

It is more than probable that even in a tuberculous reaction following reinfection the allergic manifestation is predominantly a fluid exudative reaction with the cellular elements responding merely as an infection response, which is determined by the nature of the infecting organism and the infection products. Our really destructive processes are invariably localized to individual areas, which may possibly become confluent although this is of no moment.

Whether necrosis occurs in an internal organ, as in tuberculous cavitation, lung abscess, etc., or in deeper layers of the skin, the reaction is essentially the same. The body attempts to throw off the infection in various ways, always proceeding in the direction of least resistance. A deep infection may eventually produce a long draining sinus, a lung infection which produces an intense reaction may produce a cavity draining eventually through a bronchus, while a deep skin infection (like a boil) likewise throws off infection by discharging the entire products of the reaction plus the offending organism. The animal body has adopted this method of removal of infection as perhaps the most economical method in most cases, although it proves very dangerous when used in the internal organs, they are not so often infected when compared with the innumerable cases of skin infection. If one observes a boil develop from onset, one first sees the stage of congestion. During the congestion (red) stage there surely is no tissue destruction, as such stages often subside quickly with no evidence of the infection remaining. One then gradually approaches the stage of central discoloration and blanching which indicates that the blood supply has been entirely choked off from the immediate site of infection. An anoxemia has resulted and tissue asphyxiation has begun. It is

my contention that rapid tissue necrosis cannot occur where an adequate or even partially adequate blood supply is present. Again, lung abscess, tuberculous cavitation and other abscesses are always the result of asphyxia with subsequent cell death. Infarcts show necrosis according to the degree of collateral circulation still present. Whether we have caseation or immediate liquefaction of the infected area before the necrotic elements are cast off depends upon complicated processes which have aroused much interest and speculation.

One inquires about the reaction necessary to bring about asphyxiation. It is my belief that one cannot develop an abscess unless pressure from the reaction of the site of the abscess is sufficiently high to close off the arterial blood supply to the part and produce an anoxemia. It is a known fact that pressures short of the local systolic arterial pressure will not prevent blood from entering the capillary bed of the part, although capillaries may of their own accord contract to blanch a portion of the capillary bed. Terminal arterioles may constrict to diminish the amount of blood flowing to any area. Normally capillaries may not be fully open or some may be temporarily closed, according to the tissue demands and the amount of blood circulating through the part. Certain groups of capillaries may collapse or close if the remainder of the capillaries dilate to accommodate the blood flow, but nothing short of the systolic arterial pressure of the supplying artery can stop the entire circulation of the part. Such pressures cannot develop where there are no limiting membranes. Non-encapsulated empyemas, peritonitis, mediastinal abscess, retroperitoneal abscess, etc., as such, never lead to tissue necrosis. A limiting membrane is essential. We find such a membrane in the surrounding fibrous capsule of our primary and secondary lung lobules. An appendix cannot become abscessed unless the lumen becomes blocked. Fibrous tissue has an enormous capacity for expansion, but only when the expansion can take place slowly. The areolar tissue of our skin contains in-

developmental variation. The uniformity of this extra nucleus in all four knees is striking. Likewise there occurred an independent center of ossification for the tip of the internal malleolus, bilaterally, in both sisters. The latter variation is found ordinarily in about 8 per cent of normal females at this age. The coincidence of its occurrence as well as that of the extra patellar ossification in both of the twins is highly significant of the hereditary nature of these two anatomical variations. On the other hand, the presence of two such exactly similar extra ossicles occurring in both of the twins emphasizes the uniovular character of this pair.

Another rather unusual anatomical variation, an azygos lobe fissure of the right lung, occurred in twin A alone. No evidence of such a fissure could be detected in the lung of twin B (Fig 1). So far as I can determine, no previous report bearing on the hereditary or acquired character of this uncommon anomaly has been made. In view of the fact that these twins were almost certainly monozygotic in origin, the azygos lobe of the lung would appear to be a non-hereditary variation. It is interesting to note that this conclusion corresponds with what is known by the embryologists of the development of such anomalies of the vascular system, namely, that they are due to disturbances occurring *in utero*.

Comparison of the sinus development showed striking differences between the two twins. This is consistent with the findings reported by Dillon and Gourevitch (5) and indicates that sinus development may be profoundly affected by environmental or accidental factors occurring after birth. The mastoid development, however, was reasonably similar. The size and shape of the heart showed minor differences between the two girls, the exact significance of this is not apparent.

A second pair of presumably identical twins (L), both females, aged 13 years, were submitted to general roentgen examination. The tracings of their roentgeno-

grams are shown in Figure 2. A comparison of the epiphyseal development of the extremities in these twins shows almost exact similarity. The multiple, small, irregular ossification centers of the epiphyses of the acromion process, which are not infrequent, are extremely similar in the two twins. Likewise, the rather bizarre development of the epiphysis of the trochlea was present in both in an exactly similar fashion. The similarity of appearance of the sesamoids at the metacarpo-phalangeal joint of the thumb is also notable. There is also observed rather markedly irregular os acetabuli, again present in both twins. It may be noted that the epiphysis of the tuberosity of the fifth metatarsal is developed to exactly the same degree in both sisters. When it is realized that this epiphysis is extremely variable in its time of appearance in ordinary siblings, the striking similarity of these two girls is apparent. There were no outstanding anatomical variations in twins L, the remainder of the examination indicating a relatively normal, similar development.

By contrast with the two pairs of identical twins, a pair of dizygotic, non-identical twins (M), both females aged 9 years, are presented in some detail. The tracings of their roentgenograms are shown in Figure 3. Comparison of the films of the elbow and foot show generally larger sized bones in M_2 . The difference in size of the epiphyses in the elbow, the differences in character of the epiphysis of the trochlea and the greater degree of union of the epiphysis of M_2 as compared to M_1 is very striking. It should also be noted that the epiphysis of the tuberosity of the fifth metatarsal is present in M_2 and not in M_1 . There are, in addition, a number of transverse lines of density in the distal end of the tibia in M_1 , not present in M_2 , this no doubt is of significance only as an indication of a greater number of infections and more retardation of growth. The striking dissimilarities which are present between these two sisters of exactly the same age are more characteristic of

identical doses of tuberculous infection from primary infection, different individuals would produce different degrees of sensitivity and, therefore, different tuberculosis pictures. This may explain the so-called degrees of immunity in different races or families, which is still, however, a controversial subject. I am of the opinion that allergy is perhaps our most important factor in prognosis (7). Except in widely disseminated tuberculosis, like miliary tuberculosis, meningitis, etc., the most severe cases of pulmonary tuberculosis result from spread during the heightened stages of sensitivity. Just as we have familial tendencies to asthma so do we have great variations in intensity in the response to tuberculous infection, which must depend in great measure on the individual's allergic response to such infection and reinfection.

Those who wish to dispute the above might wish to point to the clinical symptoms one encounters in tuberculosis. As far as the toxic effects of the tubercle bacillus, this is negligible as shown in the mild nature of the reaction in our primary lesion. It is also a very slowly developing organism and, therefore, we cannot attribute many of the symptoms to its digestion products. It is only after the patient has developed tuberculous sensitivity (one to three weeks) (8) that the tuberculous infection, or reinfection, produces toxic symptoms, and these must be ascribed, therefore, to the sensitivity reaction. Just what the source of the toxic symptoms is, one can only surmise, as we have several possibilities to consider. Bacterial ferment activity probably is more important when considering toxemia produced by other organisms, but not so much when considering tuberculosis. (Secondary invaders are not considered factors.) Asphyxiation with tissue death may result in the liberation of ferment (mostly proteolytic) from the destroyed cells. The white blood cells, especially the polymorphonuclear neutrophils, are normally short-lived and liberate much enzyme when destroyed. Digestion of damaged cell tissue probably produces products of digestion which are toxic.

We have normal enzymes which are incapable of digesting normal tissue but damaged tissue may be easily digested with resulting toxic symptoms. Antihormones which exert restraining influences on internal secretions, it would seem, are more easily destroyed than hormones and enzymes. Can cell death be explained on the basis that loss of certain restraining influences, possibly through lack of oxygen or some other agent, allows digestive fluids to attack our now unprotected tissue? Electrolytic changes, chemotactic influences depression of normal cellular enzymatic activity, nuclear alterations, disturbance, of normal permeability of cellular membranes, precipitation of colloid cellular elements, etc., have all been described as causes for cell death and autolysis. A number of years ago Jobling (9) described a long series of experiments in which he showed that gummas were absorbed through normal body ferment activity after iodide therapy, because of the action of iodine in producing saturated fatty acid compounds out of unsaturated fatty acid compounds in the gumma, thereby allowing normal body ferments to digest the gumma. Such events are interesting in our consideration of cellular digestion. Harmless substances may produce highly toxic digestion products through the action of bacterial ferment. It is my belief that when we speak of these as toxic products we mean chiefly their effects on the centers of the central nervous system rather than their immediate effect on the local tissue, which must be comparatively little. The local necrosis is the result of asphyxia, and whatever goes with the anoxemic state. As the pressure within the inflammatory area becomes lessened either through a discharge of the necrotic material, or through subsidence of the reaction and absorption of material, symptoms quickly subside. A positive pressure in the reaction area is essential for toxin absorption and toxic symptoms. A knife plunged into a boil reduces the pressure sufficiently to relieve most symptoms almost immediately. Absorption into the surrounding lymphatics

minor differences. Likewise the development of the sella turcica was about uniform in all three of the triplets. These findings are consistent with those of other investigators (5).

The epiphyses about the elbow, in the wrists and hands, and the carpal centers have an almost equal development. Careful measurements by Lund (12) of the size of the carpal centers of ossification show a striking similarity. The exactly similar fissuring of the epiphysis of the calcaneus should be noted. It is interesting to observe that this fissure was present in the left foot only of X and Y and in the right foot only of triplet Z. This suggests the mirror effect which is often found in identical twins.

Slight differences in ossification of the pelvis were observed, especially as to the degree of union of the three components of the acetabulum, but the differences were minor. Likewise there were slight differences in the form of the condyles of the tibia. In triplet Z there was found a phalangeal epiphysis in the small toe not observed in the other two. On the whole, the skeletal development was much more uniform than in non-identical females of the same age.

The shape of the heart was much the same in all three girls, but there were minor differences in heart size. The lungs appeared substantially the same.

The lumbosacral region presented interesting differences. In triplet X there was normal development of the lumbosacral segment of the spine. In triplet Y a congenital anomaly, consisting of a defect in the lamina of the fifth lumbar vertebra and a fusion of the left half of the lamina with that of the fourth lumbar vertebra, was found. In triplet Z an anomaly of somewhat different character, a defect in the lamina of the first sacral vertebra with a partial lumbarization of its transverse processes, was present.

Here again we find distinct differences in the anomalies of apparently monozygotic siblings. It is suggested from this that defects in the laminae of the

vertebrae, which are so common, and possibly other anomalies of this region are not hereditary. This also corresponds with our knowledge of the embryological development of this type of anomaly which is thought to develop *in utero*. Kuhne (11) likewise found from a study of twins that certain types of variations in the spine do not appear to be of genetic origin. The hereditary factor seems to influence the general arrangement and configuration of the spine. Haffner (7) reported a pair of presumably monozygotic twins both of whom had intercalated wedge vertebrae. This type of anomaly, however, is of a different character, so that his report offers no contradiction to the findings reported above. In the twins described by Harpin (8) defects in the lamina were observed in both but the identity of the twins was not clearly established.

By way of comparison with the set of monozygotic triplets, six sets of dizygotic triplets were examined. All the triplets herein reported have been the subject of a special study by Miss Ruth Howard (9). The dizygotic triplets form an exceedingly favorable group for this type of study, they present contrasting pictures of skeletal development within the same group. In one such set we are afforded the opportunity of observing the differences in development of non-identical twins and the similarities of identical twins, all of exactly the same age, family background, and with a similar environment. The influence of the genes is thus brought out in startling fashion.

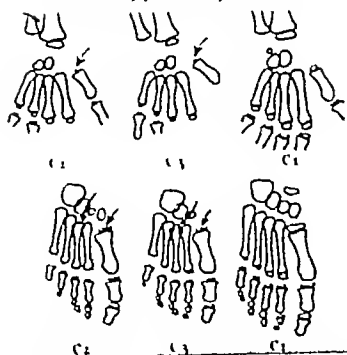
For purposes of illustration, triplets H, J, C, and G will be used. Tracings of various roentgenograms of the skeleton of triplet H are shown in Figure 5. It will be noted that H₂ and H₃, considered identical, were both males, 13 years of age. H₁ was a female and the difference in sex at once indicates positively that the set of triplets are not uniovular. The exact likeness which the roentgenograms of the elbows, hands and wrists, hips, and feet of the two male members of the set bear each other, indicates clearly their

ingestion of certain food-stuffs which "always cause distress," present the symptoms of acute gastric ulcer and, in some cases, definite x-ray ulcer findings, and in others what is commonly termed "duodenitis," one cannot dismiss the possibility of food allergy being the causative agent in the production of many peptic ulcers. Sensitization to infection, pollens, or chemicals could also be a factor in some ulcers. I personally prefer to view certain phenomena that may accompany gastric and duodenal ulcers of rather diagnostic significance. It has been my experience that a fairly high proportion of such ulcers are accompanied by markedly thickened gastric rugæ, and this has generally been termed an accompanying gastritis, thought to be produced by ulcer irritation of the entire stomach with resulting pylorospasm, hyperacidity, and congestion. More recently I have been of the opinion that the congested thickened gastric rugæ could better be explained as an allergic manifestation, of greater or lesser duration and acuteness, and of which the ulcer may be a more outspoken manifestation. With this in mind it is more than probable that neither bleeding, hyperacidity, pain, spasm, or increased peristalsis need constitute the really acute phase of an ulcer, but that the accompanying allergic reaction (swelling and injection) constitutes the background for acute activity and reactivation of ulcer areas. These ulcers would be the result of the anoxemia of the tissue from pressure effects, perhaps aggravated by trauma. Pain and variations in gastroduodenal activity are exaggerated during the hypersensitivity reaction. One might assume that healing would be promoted by avoiding anything that might induce a local allergic state. So-called "tension ulcers" have been variously described recently. Nerve strain, tension, worry, have been forerunners of many ulcers, usually duodenal, and mental relaxation seemed to result in prompt cure or at least improvement in most of such cases. It may be assumed that the sympathetic vascular nerve endings are re-

flexly stimulated through the higher nerve centers, to produce our histamine-like substance (Lewis' H-substance). I should personally prefer to avoid the use of any intermediary H-substance in order to explain such phenomena. Considering all things, it would seem that the local histamine-like substance would need to be the same in different forms of allergy, but with the necessity of the sympathetic nervous mechanism becoming sensitized to each allergen in turn. The H-substance would be produced only when the nervous mechanism stimulated its production, and probably does so only during the allergic reaction, and is perhaps limited to the area of allergic manifestation. Higher nerve centers, as shown above, have a marked influence on the autonomic mechanism, and *vice versa*. It is conceivable that irritation of the gastro-intestinal nervous mechanism at any point may ultimately result in ulcer formation at some other point through the same allergic process. The frequent association of a duodenal ulcer with a so-called chronic appendix may be so explained, or are we dealing with an appendix also in a allergic state? Rowe (5) has called attention to appendices which are swollen and injected and are definitely in an acute allergic state. There are those who claim that the pendulum has swung too far in our classification of allergic states, and perhaps this article would appear to exaggerate the condition. Much depends upon one's viewpoint in explaining such events.

Certain individuals frequently present a museum of allergic manifestations. One particular case I recall presented almost every variety of allergic manifestation, although, fortunately, only one allergic condition presented itself at any one time. Amongst the symptoms were "vacuum sinus" headache, some polypoid and nasal sinus membrane swelling, hay-fever, urticaria, eczema, asthma (very severe at times), and abdominal distress, originating mostly in the gall bladder and proximal colon areas. During one of these abdominal attacks the entire colon and especially

Triplets C Age 3 years All ♀
(C₂ and C₃ probably identical)



Triplets G Age 6 years All ♂
(G₂ and G₃ probably identical)

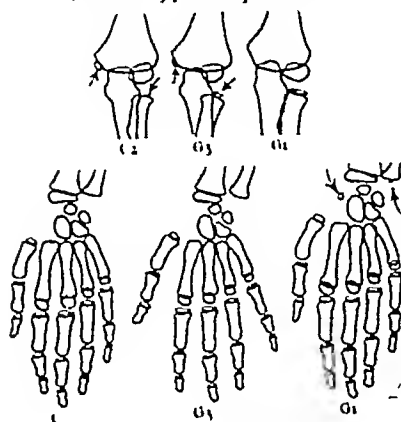


Fig 7 (above)
Fig 8 (below)

olecranon has already appeared in J₂ while still absent in the other two. The foot shows similar epiphyseal development but here there are two anatomical variations of considerable interest. The first, a small exostosis on the medial side of the second metatarsal, in exactly the same location in J₁ and J₃, is absent in J₂. The second, a separate ossification center for the tip of the medial malleolus, is present in J₁ and absent in the other two. The epiphysis of the calcaneus is the same size in the identical pair, much larger in the odd member of the set. The latter shows the early appearance of an os trigonum, another anatomical variation which is not apparent in the identical pair. In this group, at least one anatomical

variation, an exostosis of the metatarsal, is clearly shown to be hereditary in origin by its exactly identical appearance in both of the monozygotic twins. It would be an extremely rare coincidence to discover this unusual finding in precisely the same location in both of these twins if they were not uniovular and the variation were not chromosomal in character. On the other hand, the presence of the other two variations, the os trigonum and the extra epiphysis for the medial malleolus, in one member of the set alone, helps to establish definitely the dizygotic origin of these triplets.

Triplets C were three years of age and all female. They appeared by most tests to be dizygotic, with C₂ and C₃ considered probably identical. In Figure 7 are illustrated tracings of roentgenograms of the hands and feet only, as these alone showed significant similarities and differences. Again there is apparent a marked advancement in the degree of ossification of one member of the set, C₁, as compared to the other two, in spite of the uniform sex of all three. The irregularities, atypical pseudo-epiphyses, at the proximal ends of the metatarsals, of C₂ and C₃, which are almost duplicated, are in contrast to the more average ossification of the metatarsals of the odd member of the set.

The final set of dizygotic triplets to be illustrated were all males, six years of age. Tracings of the roentgenograms of the elbows, hands and wrists are shown in Figure 8. The findings, in general, are of the same character as those described above with certain interesting minor differences. It is apparent at once that the development of the epiphyses about the elbow is somewhat more advanced in G₂ and G₃ than in G₁, the odd member of the set. In the identical pair the epiphysis for the medial epicondyle is present while absent in the non-identical triplet. On the other hand, the epiphysis for the head of the radius is much larger in the latter than in the other two. The same similarities and differences are present in the hands where the ossification of G₁

requires further elucidation. In the acute tuberculous exudates there is at present no question but that allergy is an essential element of the reaction. I have stated above that the cellular infiltrations were perhaps separate from the purely exudative allergic phase which was primarily concerned with the exudation fluid, the cellular elements depending upon the nature of the offending organism and the reaction products. These cellular elements vary more or less with the changing local conditions. In non-septic allergic exudates we often find an eosinophilic cellular infiltration along with other cell types. I have been of the opinion for many years that the fundamental process of necrosis was the same in pulmonary tuberculous cavitation and cavitations from other infections, such as we see in lung abscess. In the latter, cellular elements perhaps predominate and are more important in the production of exudation pressures. We can still maintain that exudates produce the lung abscess by tissue asphyxiation through pressure effects, regardless of whether or not hypersensitivity plays an important part here also.

The development of sensitization has been discussed and in the absence of proof, theoretical explanations only can be offered. Sensitization of the autonomic vascular nervous mechanism is our fundamental explanation of the exudation process. Earlier ideas of the necessity of protein elements for the production of such a sensitization no longer explain many of the conditions now included in "allergy." In my estimation, direct or indirect stimulation of the autonomic vascular nervous system by sensory or reflex stimuli may bring about such a sensitization. Just where in the autonomic nervous system sensitization occurs has not been determined. It may occur at the peripheral nerve endings, the ganglia, or possibly in inter-brain centers. There is evidence pointing to each of these possibilities. Whether or not such a sensitized nervous mechanism ultimately always functions through the production of a histamine-like

substance may be open to argument. The production of duodenal ulcer from the excessive use of tobacco and opium derivatives has been explained as being due to a paralytic action on the ganglia of the duodenal sympathetics. Cushing has described duodenal ulcers associated with inter-brain lesions which are thought to produce a sympathetic "imbalance" (15). Rokitsansky and Virchow were long ago of the opinion that most peptic ulcers were of neurogenic origin.

I prefer to consider pneumonic infection as primarily a bronchial block, with subsequent exudation of reaction products into the obstructed lobe or lobule (13, 14). In some cases abscess results if asphyxiation of the infected area develops. Here again the question arises as to whether the anoxemia is a result of thrombosis or exudation pressure. Thrombosis, as stated above, appears with abscess but must appear late as a result of blood stagnation. When thrombosis does occur early we lack the cellular exudation products and we develop a so-called "dry" gangrene, as in gangrene of the bowel from mesenteric thrombosis, and in many other conditions where the blood supply is shut off without inflammation. Whether allergic reactions require entirely specific stimulation or may be non-specifically stimulated has been frequently discussed. It is generally admitted that non-specific protein elements may produce what appear to be the equivalent of modified specific reactions.

CONCLUSION

Acute tissue necrosis proceeds in a very complicated manner. Anoxemia from tissue reaction pressure is probably the underlying cause of cell death in the conditions described, and there are numerous explanations of events. Allergic manifestations precede such necrosis. The production of cavitations, dental apical abscess, peptic ulcer, and other conditions are described on an allergic basis. In such a controversial subject I consider it necessary that fundamental ideas which bring about the main assertions be considered, even though they

2 The identical or non-identical character of these multiple birth siblings had been previously established to a considerable degree by various clinical and anthropometric tests

3 The roentgen findings were in general agreement with the clinical and anthropometric data, although there were differences in certain cases

4 The development of the paranasal sinuses differed markedly in the identical twins and triplets. The mastoids tended to be fairly similar, while the sella turcica tended to develop in very similar fashion

5 A certain similarity in cardiac development was observed in the monozygotic siblings but it was not marked

6 In the monozygotic twins and triplets and in the monozygotic pair of the sets of dizygotic triplets, skeletal development, both as to its rate and character, was observed to proceed along strikingly similar lines. In the non-identical siblings marked differences were present. The similarities and differences were most obvious in the younger children at the ages when many epiphyses are present

7 Certain anatomical variations were encountered in both members of pairs of identical twins, namely, an extra ossicle for the patella, a separate epiphysis for the tip of the medial malleolus of the tibia, variations in the number of ossification centers for the epiphysis of the acromion process of the scapula and for the trochlea of the humerus, the os acetabuli, pseudo-epiphyses of the metatarsals, and an exostosis of the metatarsal

8 An azygos lobe of the right lung was found in only one of identical twins

9 Anomalies of the lumbosacral segment of the spine were found of varying character in two of three members of a set of monozygotic triplets

CONCLUSIONS

1 The roentgen method is of great assistance in determining definitely the identical or non-identical character of twins or triplets. When combined with

clinical and anthropometric data, roentgen findings may produce a conclusive determination of this important question

2 Roentgen study of multiple birth siblings whose monozygotic origin is known may reveal data leading to a conclusion as to the hereditary or non-hereditary nature of anomalies and anatomical variations

3 From the findings in this series of cases it seems probable that the rate and character of growth of the skeleton and anatomical variations such as extra ossicles, extra ossification centers, irregularity of ossification centers, exostoses, of a certain type, and the number and location of sesamoids are of hereditary origin and are likely to be exactly similar in monozygotic siblings

4 Such anomalies as the azygos lobe of the lung and defects in the laminae of the vertebrae do not appear to be hereditary, the number of cases being insufficient to allow one to draw positive conclusions

5 The roentgen examination of multiple births is of great value in the study of the effects of heredity and environment

BIBLIOGRAPHY

- (1) BUSCHKE, F. Roentgenologische Skelettstudien an Menschlichen Zwillingen und Mehrlingen G. Thieme, Leipzig, 1934
- (2) Idem. Acta Radiol., 1934 15, 502-507
- (3) Idem. Klin. Wchnschr. June 30, 1934 131, 944-949
- (4) Idem. Jour. Hered. October 1935 26, 391-410
- (5) DILLON I. G. and GOREVITCH, I. B. Am. Jour. Roentgenol. and Rad. Ther. 1936 35, 782
- (6) GOREVITCH I. B. Fortschr. a. d. Geb. d. Röntgenstrahlen July 1936 54, 62-68
- (7) HAFNER, J. Acta Radiol. 1936 17, 529-541
- (8) HARPIN R. New Eng. Jour. Med., April 15 1937, 216, 658-659
- (9) HOWARD, RUTH. Developmental Study of Triplets. Inst. of Child Welfare Univ. of Minn. 1934 Circular No. 5
- (10) JOFFICH G. Monatschr. f. Kinderh. 1936 67, 168-178
- (11) KÜHNE K. Ztschr. f. Morphol. u. Anthropol. 1936, 35, 1-376
- (12) LUND S. E. T. Human Biol. February 1933 5, 1-34
- (13) MCBROOM D. and GRAY R. C. Arch. Neurol. and Psychiat. April 1934 31, 824-836
- (14) SCHINZ H. R. Deutsche Ztschr. f. Chir. 1936 247, 728-773
- (15) WAGNER W. Deutsche Ztschr. f. Nervenhe. 1936 139, 103-106

ROENTGEN STUDIES OF TWINS AND TRIPLETS¹

By LEO G. RIGLER, M.D., *Minneapolis, Minnesota*

Department of Radiology, University of Minnesota

DURING the past decade numerous investigations of the physical and mental characteristics of multiple birth siblings have been undertaken, largely with a view to determining the relative effectiveness of heredity and environment upon the individual. In studies of this type it is of crucial importance to determine the monozygotic or polyzygotic character of the multiple births, it is only from identical twins or triplets that conclusions can be drawn as to the effects of heredity. The determination of a monozygotic origin, however, is not at all simple. Numerous factors such as the history of the condition of the birth membranes, the number of placenta, anthropometric measurements, general physical appearance, finger prints, palm patterns, foot prints, dental measurements, psychological measurements, blood grouping, and sex must be considered. Unfortunately there is no absolute proof on this matter although reasonably positive conclusions may be drawn from a consideration of all the data at hand.

Through the kindness of a number of investigators at the University of Minnesota, including Dr. S. E. Torsten Lund and Miss Ruth Howard of the Institute of Child Welfare, Dr. Royal Gray of the Division of Neurology and Psychiatry, and Dr. Louise Frary of the Department of Pediatrics, I was enabled to submit a number of multiple birth siblings to roentgen examination of the skeleton, paranasal sinuses, mastoids, sella turcica, lungs, and heart. This was done in order to determine, if possible, the help which this type of examination might give in arriving at a definite conclusion as to the

identical or non-identical character of twins or triplets. In 1933, at the annual session of the American Medical Association, some of the results of this investigation were presented in the form of an exhibit. Prior to this time there had been few large-scale investigations of twins and triplets by the roentgen method. In 1934, Buschke (1), in an exhaustive monograph, including a review of the literature, reported on a similar study of 50 pairs of twins, four sets of triplets, and one set of quadruplets. In the American roentgen literature, there are practically no papers of this kind, a notable exception being that of Dillon and Gourevitch (5), in 1936.

There are now appearing, particularly in the literature on biology and eugenics, numerous papers detailing similarities of identical twins and triplets. In many of these the roentgen method of study is used. Recent reviews of the literature by Joppich (10), McBroom and Gray (13), Lund (12), and Kuhne (11) give some idea of the extent of the interest in this subject. The latter, for example, has written a complete monograph on the roentgen study of the spines of twins, with a view to establishing whether or not the variability of development of the spine is hereditary or acquired. In a similar way, Gourevitch (6) studied the heart size in both monozygotic and dizygotic twins to determine the effects of heredity on this portion of the anatomy. Dillon and Gourevitch (5) examined the mastoids, paranasal sinuses, and sella turcica in similar fashion, while Wagner (15) has studied roentgenograms of the whole skull. Schinz (14), in a consideration of the hereditary nature of tumors in man, has collected all the reports of twins in whom similar and dissimilar tumors were found. Numerous other applications of this

¹ Presented at the Fifth International Congress of Radiology, Chicago, Illinois, Sept. 13-17, 1937.

2 The identical or non-identical character of these multiple birth siblings had been previously established to a considerable degree by various clinical and anthropometric tests

3 The roentgen findings were in general agreement with the clinical and anthropometric data, although there were differences in certain cases

4 The development of the paranasal sinuses differed markedly in the identical twins and triplets. The mastoids tended to be fairly similar, while the sella turcica tended to develop in very similar fashion

5 A certain similarity in cardiac development was observed in the monozygotic siblings but it was not marked

6 In the monozygotic twins and triplets and in the monozygotic pair of the sets of dizygotic triplets, skeletal development, both as to its rate and character, was observed to proceed along strikingly similar lines. In the non-identical siblings marked differences were present. The similarities and differences were most obvious in the younger children at the ages when many epiphyses are present

7 Certain anatomical variations were encountered in both members of pairs of identical twins, namely, an extra ossicle for the patella, a separate epiphysis for the tip of the medial malleolus of the tibia, variations in the number of ossification centers for the epiphysis of the acromion process of the scapula and for the trochlea of the humerus, the os acetabuli, pseudo-epiphyses of the metatarsals, and an exostosis of the metatarsal

8 An azygos lobe of the right lung was found in only one of identical twins

9 Anomalies of the lumbosacral segment of the spine were found of varying character in two of three members of a set of monozygotic triplets

CONCLUSIONS

1 The roentgen method is of great assistance in determining definitely the identical or non-identical character of twins or triplets. When combined with

clinical and anthropometric data, roentgen findings may produce a conclusive determination of this important question

2 Roentgen study of multiple birth siblings whose monozygotic origin is known may reveal data leading to a conclusion as to the hereditary or non-hereditary nature of anomalies and anatomical variations

3 From the findings in this series of cases it seems probable that the rate and character of growth of the skeleton and anatomical variations such as extra ossicles, extra ossification centers, irregularity of ossification centers, exostoses, of a certain type, and the number and location of sesamoids are of hereditary origin and are likely to be exactly similar in monozygotic siblings

4 Such anomalies as the azygos lobe of the lung and defects in the laminae of the vertebrae do not appear to be hereditary, the number of cases being insufficient to allow one to draw positive conclusions

5 The roentgen examination of multiple births is of great value in the study of the effects of heredity and environment

BIBLIOGRAPHY

- (1) BUSCHKE, F. Roentgenologische Skelettstudien an Menschlichen Zwillingen und Mehrlingen. G. Thieme, Leipzig, 1934.
- (2) Idem. Acta Radiol. 1934, 15, 502-507
- (3) Idem. Klin. Wchnschr. June 30, 1934, 131, 944-949
- (4) Idem. Jour. Hered., October 1935, 26, 391-410
- (5) DILLON, I. G. and GOUREVITCH, I. B. Am. Jour. Roentgenol. and Rad. Ther., 1936, 35, 782
- (6) GOUREVITCH, I. B. Fortschr. a. d. Geb. d. Röntgenstrahlen. July, 1936, 54, 62-68
- (7) HAFNER, J. Acta Radiol. 1936, 17, 529-541
- (8) HARPER, R. New Eng. Jour. Med. April 15, 1937, 216, 658, 659
- (9) HOWARD, RUTH. Developmental Study of Triplets. Inst. of Child Welfare, Univ. of Minn. 1934. Circular No. 5
- (10) JOPPICH, G. Monatschr. f. Kinderh. 1936, 67, 166-178
- (11) KÖHNE, K. Ztschr. f. Morphol. u. Anthropol. 1936, 35, 1-376
- (12) LUND, S. E. T. Human Biol. February 1933, 5, 1-34
- (13) MCBROOM, D. and GRAY, R. C. Arch. Neurol. and Psychiat. April 1934, 31, 824-836
- (14) SCHINZ, H. R. Deutsche Ztschr. f. Chir. 1936, 247, 728-773
- (15) WAGNER, W. Deutsche Ztschr. f. Nervenhe. 1936, 139, 103-106

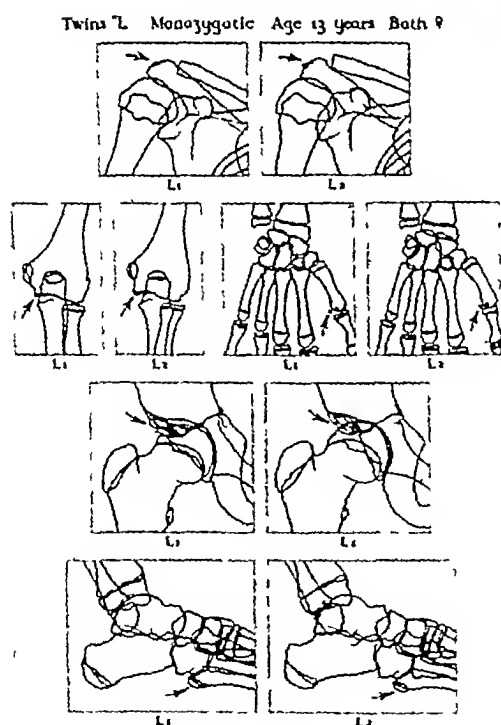
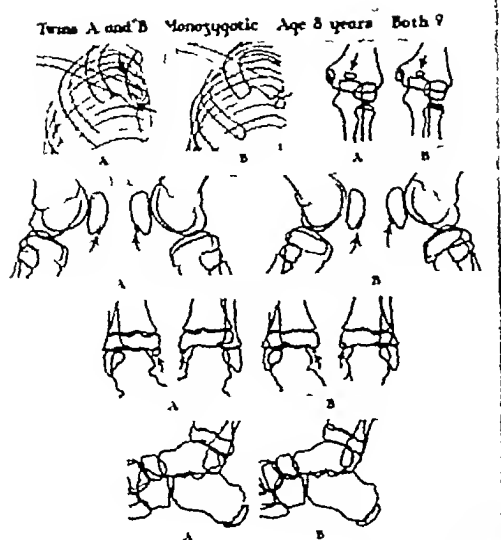


Fig 1 (above)

Fig 2 (below)

the most interesting findings in this pair of twins. Both of them exhibited an extra ossification center for the patella on its anterior surface. This was bilateral and represents a rather unusual

PATHOLOGY

Pneumothorax is the accumulation of air in either or both pleural cavities, associated with a varying degree of lung compression. Displacement of medias-

2 *Closed Type*—The point of rupture in the lung becomes sealed quickly. The amount of air thus admitted into the pleural cavity before closure of the tear is variable, depending upon the size of the

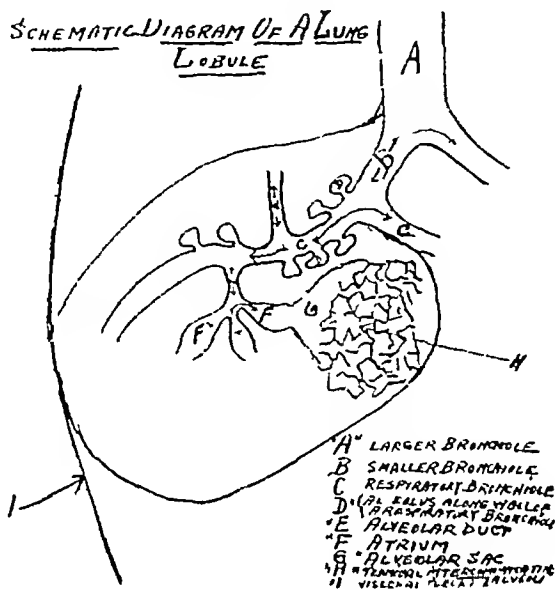


Fig 1

tinal structures takes place to the opposite side in complete unilateral pneumothorax, unless the mediastinum has become fixed by a pathologic process. Spontaneous pneumothorax is accidental and incidental to pathologic change and in the idiopathic cases is a result of "natural wear and tear." The direct cause of spontaneous pneumothorax is a tear in the visceral pleura and subjacent lung structure. There are three types, namely:

1 *Open Type*—Air enters and leaves the pleural cavity through the point of rupture in the lung during inspiration and expiration, respectively. An amount of air sufficient to overcome the negative pressure is thus introduced, the lung collapses and the quantity of air in the pleural cavity remains stationary until slow absorption of air and lung expansion commences, whereupon the tear in the lung and pleura heals.

rupture and the amount of positive pressure necessary to cause sufficient lung collapse to permit such closure. This type usually causes only partial collapse and milder symptoms.

3 *Valvular Type*—In this type, entrance but not exit of air into the pleural cavity is permitted. Air thus continues to accumulate, being "sucked" in with every inspiration and affording no means of exit during expiration. The mediastinum is displaced to the opposite side, the opposite lung becomes compressed, and the symptoms quickly become very severe, necessitating immediate relief by means of deflation.

ETIOLOGY

Primary, essential, or idiopathic spontaneous pneumothorax occurs in otherwise apparently healthy individuals. It is comparatively rare. It occurs more com-

laminae, multiple epiphyseal centers, extra ossicles and others of a similar nature

The data on five pairs of twins and nine sets of triplets have been collected for this study and some of these will be reviewed in detail with illustrations. It should be noted that the clinical and anthropometric observations, as well as some of the roentgen findings, in many of these multiple births have been presented in greater detail by others, as will be noted below. For this reason, no effort will be made in the course of this paper to discuss the clinical and anthropometric findings in these twins and triplets in detail. Only a summary of the important roentgen findings can be given, but emphasis will be placed on the striking similarities and striking differences which are present. It should be noted that, independently of the roentgen findings, an extensive effort has been made in each instance to determine, by numerous measurements and tests, the identical or non-identical character of the twins or triplets. It is not possible in all cases to be absolutely certain as to this, and when doubt exists it will be so indicated. In general, the roentgen findings have correlated extremely well with the conclusions arrived at by other methods of approach.

ROENTGEN STUDIES OF TWINS

A set of female, epileptic twins (A, B) appearing by most tests to be monozygotic, which have been previously reported by McBroom and Gray (13) were submitted to roentgen examination of the entire skeleton, the heart, and lungs. Tracings of the more important roentgenograms are shown in Figure 1. An exact similarity of epiphyseal development was found throughout the skeleton. This is demonstrated particularly well in the elbow, knee, ankle, and foot. The equality in size of the epiphyses in the elbow and the exactly similar fissuring of the epiphysis of the calcaneus are notable.

A number of rather unusual anatomical variations occurred and these presented

of such an accident in so select a location is what makes true "idiopathic" spontaneous pneumothorax of rare occurrence

DIAGNOSIS

Sudden sharp pain in one side of the chest accompanied by increasing dyspnea and possibly collapse suggests spontaneous pneumothorax, physical signs and x-ray examination corroborate it. If a healthy individual or one having slight pulmonary or pleural pathology, up and about his daily routine, is suddenly seized with the above-named symptoms, spontaneous pneumothorax must be suspected. The diagnosis can often be made on the characteristic symptoms and general appearance of the patient if seen shortly after the onset. The physical signs are variable and in themselves are not conclusive, unless in complete collapse with displacement of the mediastinum. The most important diagnostic aid in suspected cases and corroborative proof in diagnosed cases, is the fluoroscope and roentgenogram.

PROGNOSIS

1 If essential, or secondary to slight pleural or pulmonary pathology, recovery is the rule.

2 Spontaneous pneumothorax complicating far advanced active pulmonary tuberculosis, is a very serious and usually terminal condition.

3 When complicating pneumonia, it is serious though not necessarily hopeless.

4 When secondary to malignancy, the prognosis is that of the primary condition.

From the standpoint of pathology the prognosis is much better in the open and closed types. The valvular type causes the most severe symptoms, and on account of treatment necessary makes this type more prone to complications, e.g., serous or purulent effusion.

TREATMENT

Uncomplicated spontaneous pneumothorax with symptoms not distressing requires only rest and symptomatic medi-

cation. If dyspnea becomes marked and the pneumothorax side is greatly distended with air, as is almost always the case in the valvular type, deflation should be resorted to. The method described by Watterson (15) is a very practical one. The Robinson artificial pneumothorax apparatus is reversed, the proximal bottle being filled with water while the distal bottle is dropped to a lower level. The water siphons from the proximal into the distal bottle, creating a vacuum in the proximal bottle. Manometric readings are made before deflation is begun and after withdrawal of every 200 c.c. of air, which is measured by water displacement in the proximal bottle. If the apparatus is not available, a trocar and cannula may be used and, where air re-accumulates rapidly, a rubber tube inserted through the cannula may have to be left *in situ* for some time. The amount of air withdrawn varies from 800 to 3,000 c.c. The operator should never withdraw all the air, any more than he would think of tapping a chest dry of an effusion. In far-advanced active, pulmonary tuberculosis deflation should be performed to relieve respiratory distress. In this connection, Stewart (16) of Veterans Administration Facility, Castle Point, N. Y., reports a very interesting case, in the Medical Bulletin of the Veterans Administration, March, 1932. A patient who had a far-advanced lesion with cavitation and moderate toxicity, in a fit of temper, attempted to climb the wall of a toilet which was locked. He collapsed and was found to have a spontaneous pneumothorax which almost asphyxiated him. He was pulseless when put to bed. The urgency of the case caused the ward surgeon to introduce two non-sterile needles through non-sterile skin into the pleural cavity. The needles were anchored and allowed to remain undisturbed for three weeks. No infection followed. His condition improved remarkably. He became afebrile, put on weight, and his symptoms ameliorated rapidly. Prior to this accident, his two-year stay at the institu-

our general experience with regard to the development of the skeleton in children and contrasts sharply with the exact similarity previously noted in the monozygotic pairs

Two other pairs of non-identical twins were studied, both were females, one aged six and one-half months and the other seven years. In both of these, dissimilarities of epiphyseal development were apparent, similar to twins M, but without such extreme variations. It is apparent at once from an examination of both the twins M (Fig 3), and the numerous films made on other pairs of non-identical twins that considerable variation in epiphyseal and bone development may occur in siblings of exactly the same age. This emphasizes all the more the value of the roentgen examination in establishing the identical or non-identical character of twins.

ROENTGEN STUDIES OF TRIPLETS

Roentgen examination of the entire skeleton, including the spine and skull, and of the thorax, was made in a set of female triplets (X, Y, Z) aged nine years. Based on all the assembled evidence, these appeared in all probability to be of monozygotic origin. They have been reported in great detail by Lund (12), who studied them intensively both from the physical and psychological standpoint. Studies of the skeleton of identical triplets have been reported very rarely (3, 4), hence the findings observed in these sisters are of considerable interest.

Tracings of many of the roentgenograms of the set of presumably identical triplets are illustrated in Figure 4, but the films of the spine are not included in this drawing. The paranasal sinus development is seen to be more similar than is usually found in children of exactly the same age. Nevertheless there are distinct differences which may be related to the evidences of sinus infection found in two of the sisters, the third being normal. It seems reasonable to suppose that the

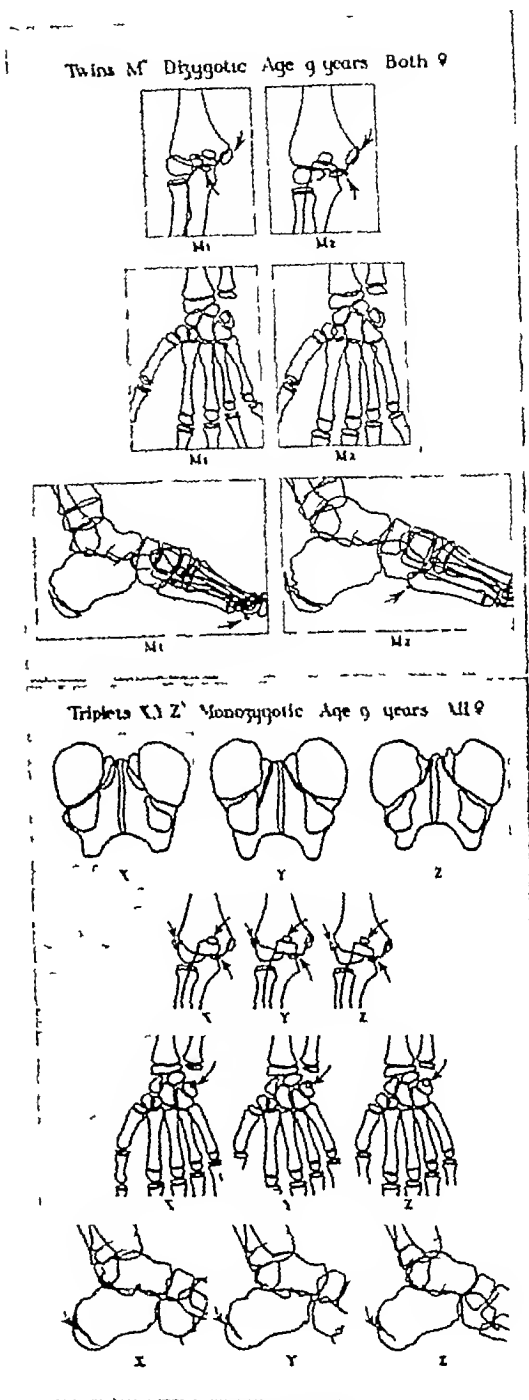


Fig 3 (above)

Fig 4 (below)

effects of acquired infections may account for the differences which are apparent. On the other hand, there was a striking similarity in the development of the mastoid processes in all three with only

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monozygotic origin. On the other hand, the same parts of H_1 , the female member of the set, all show the more advanced ossification which is to be expected because of the difference in sex. It is to be noted that all the epiphyses about the elbow are still distinct in the males while only the medial epicondyle remains ununited in the female. In the hand there is present a sesamoid bone at the metacarpo-phalangeal and interphalangeal joints of the thumb in H_2 and H_3 while in H_1 only one sesamoid is apparent, that at the metacarpo-phalangeal joint. An os acetabuli is present in the hips of the identical pair and not seen in the non-identical member of the set. The size and position of the epiphysis of the tuberosity of the ischium is likewise similar in the male members, dissimilar in the female member of the set. The foot shows a striking equality in size, shape, and position of the bones and their epiphyses in H_2 and H_3 with almost as striking an inequality in H_1 . Particularly to be noted are the epiphysis for the tuberosity of the fifth metatarsal, present in H_2 and H_3 , probably already united in H_1 , open epiphyseal lines in the phalanges of H_2 and H_3 which in H_1 are closed except for the proximal phalanx of the great toe. The remaining portions of the skeleton gave consistent findings although those illustrated were the most obvious.

A set of dizygotic triplets (J), nine years of age, all of whom were female, is illustrated in Figure 6. J_1 and J_3 appeared to be identical, J_2 , non-identical. The paranasal sinuses are illustrated here and indicate no apparent similarity, a finding consistent throughout the study. In the elbows, however, striking similarities and differences may be observed. It is apparent that ossification is more advanced in J_2 than in J_1 and J_3 in spite of their similar sex and age. The epiphyses for the capitulum, medial epicondyle and head of the radius are all larger in J_2 than in the identical pair. Likewise the osseous center for the epiphysis of the

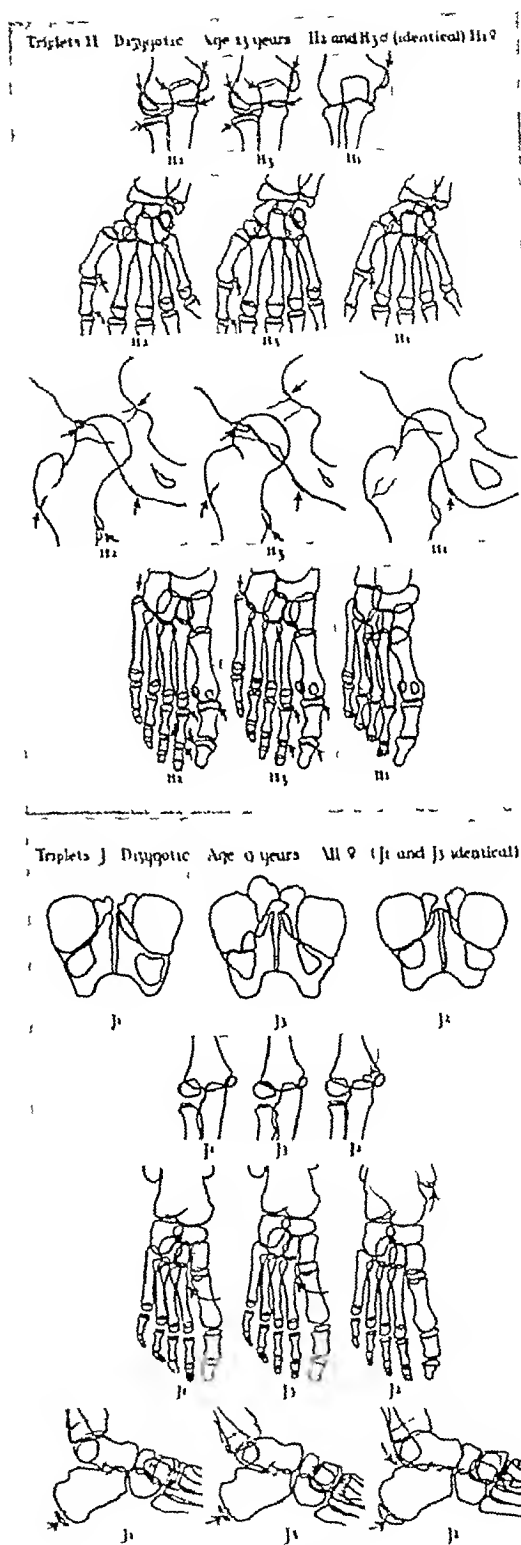


Fig 5 (above)

Fig 6 (below)

the solidified lung, with apparently no change in the extent of the pneumothorax. Aspiration of air was decided upon, but

The previous history was that he had had an attack of spontaneous pneumothorax while crossing the Atlantic in June,



Fig 5 (top) Case 3 Pneumothorax in right chest chiefly in upper part and base

Fig 6 A (bottom) Case 3 Increase of pneumothorax one week later

Fig 6 B Complete re expansion of right lung with old tuberculous changes seven weeks later

the infant died the following day. Consent was not given for a necropsy.

Case 5 This case is one of spontaneous pneumothorax, recurring three times in the same lung, at intervals of about two years with complete re-expansion each time. The condition is non-tuberculous.

This patient was 40 years of age at the time of his first attack. His occupation was that of a silk merchant. He was observed by the author (A S) during the second and third attacks.

1925. He also had a chronic cough, which was diagnosed as chronic bronchitis.

On the morning of June 27, 1928, he woke up with severe pain in the left side of chest and dyspnea. Suspecting a recurrence of an attack similar to the one of two years before, he called A S within one-half hour of inception of his pain. The patient was in bed, was pale and moderately dyspneic. He seemed to splint his left side. His temperature was 98, pulse 88. There were marked lagging,

is generally more advanced than that of G_2 and G_3

Two sets of apparently trizygotic triplets were examined. The roentgen findings in one of these, triplets F, all female, sixteen years of age, are illustrated in Figure 9. The various anthropometric data on these three girls were at variance and there is no way of determining with complete certainty that they were tri-ovular in origin. Most of the findings support this thesis. Roentgenologically, also, there is considerable difficulty, largely because ossification of the epiphyses had proceeded so far that distinction on this basis was hampered. Nevertheless certain differences appear which are demonstrated by the tracings of the roentgenograms shown in Figure 9. Note should be made particularly of the differences in the degree of union of the distal epiphyses of the radius and ulna, all three being at variance. Likewise the number and distribution of the sesamoids are unlike in all three, F_1 has four, F_2 , only two, while F_3 has five of unusual character. The dissimilarity of the irregular epiphyses of the transverse processes of the vertebrae is clearly apparent. Here again there is a laminal defect in one of the trio, but this probably has little significance. The degree and character of the ossification of the epiphysis for the tuberosity of the ischium differs to a moderate degree. Finally, there is an accessory scaphoid ossicle in the foot of F_2 which is not found in either of the other two girls. A critical study of all three indicates the possibility that F_1 and F_3 are identical, with F_2 as the odd member of the set. This was also slightly indicated by the anthropometric data but the preponderance of evidence favors a trizygotic origin. There are differences in this set which might be expected of sisters of exactly the same age who originate from different ova.

Three other sets of triplets, one possibly trizygotic and two probably dizygotic, were studied with similar results. Considering all nine sets of triplets, it seemed possible from the roentgenologic data

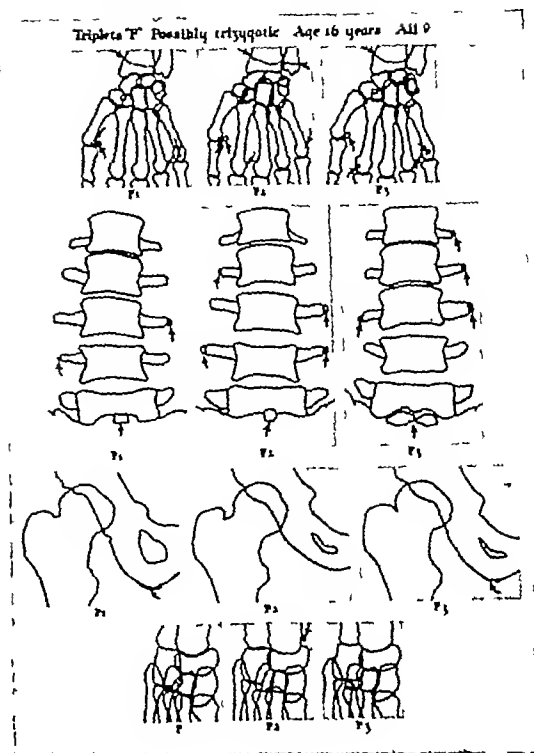


Fig 9

alone to make a fairly definite statement as to the identical or non-identical nature of the members in six sets. As to the other three, there was considerable doubt. In general, these results were in agreement with the conclusions drawn from the criteria mentioned in the first paragraph. Certain cases, in which the anthropometric and clinical data were ambiguous, gave very definite roentgenologic conclusions. In other instances the reverse was true. A combination of both types of information, in almost all instances, yielded a definite determination as to the mono-, di-, or trizygotic nature of the triplets.

SUMMARY

1. Roentgenologic studies of the skeleton, paranasal sinuses, mastoids, sella turcica, heart, and lungs of five pairs of twins, including two monozygotic and three dizygotic pairs, and nine sets of triplets, including one probably monozygotic, two probably trizygotic, and six dizygotic sets, are reported.



Fig 9 (left) Case 5 Complete left pneumothorax with mediastinal deviation

Fig 10 (right) Case 6 Complete left pneumothorax with mediastinal deviation to the right

showed hyperresonance with absent breath sounds over the left lung. The heart showed signs of being pushed to the right. The right lung had scattered, sibilant, and musical râles with medium, moist râles in the axillary area of the base. X-ray examination corroborated the physical signs of complete spontaneous pneumothorax of the left chest, with displacement of the heart and mediastinum to the right. A thick, adhesive band was noted binding down the left lung (Fig 10).

The same physical signs and fluoroscopic findings are present to date. Clinically, the man remains well-nourished and looks quite well. He is moderately dyspneic and has a chronic cough, but attends to business daily. I (A. S.) see him regularly once a month and keep on telling him that one of these fine days we will go in, cut the adhesion binding his left lung, and possibly cause it to re-expand.

Case 7. Male, 30 years of age, sign painter, was seen by D. E. E. in consultation at the Health Department, Mott Haven Tuberculosis Clinic, Bronx. Admitted Oct. 29, 1935, from Bronx city hospital where he had been from July 28, 1935, to Oct. 1, 1935. Diagnosed as a case

of left pleural effusion with pulmonary tuberculosis. Numerous examinations of the sputum done and no tubercle bacilli were found. Guinea pig inoculation of chest fluid proven negative. Numerous x-ray examinations show thickened pleura with a slight amount of fluid at the base and partial pneumothorax. The upper and lower lobes were partly collapsed. A large cavity was noted in the lower part of the collapsed lobe. Diagnosis on admission to the Clinic was chronic pulmonary tuberculosis (2-A). At time of admission to the hospital, the patient complained of high temperature and profuse perspiration of one week's duration, slight cough, scanty expectoration, no hemorrhage, occasional dyspnea on exertion, pain in left side and back. Previous history of measles and whooping cough in childhood.

At the Health Department Clinic numerous physical examinations were made Dec. 9, 1935, and March 16, 1936, showing at first a re-expanding pneumothorax in the left chest, April 13, 1936, diminished breath sounds over the left upper lung. Jan. 14, 1937, physical examination negative.

Sputum examination on six separate

SPONTANEOUS PNEUMOTHORAX¹

By DAVID E. EHRLICH, B A, M D, Consulting Roentgenologist to the Clinics, Department of Health, City of New York, and ALEXANDER SCHOMER, M D (by invitation), U S Veterans Administration Facility, Bronx, New York

INTRODUCTION

SPONTANEOUS pneumothorax has long been associated with pulmonary tuberculosis, particularly as a complication of the more advanced active stages of that disease. The first to describe pneumothorax was Itard, in 1803, and Lænnec is said to have been the first to have diagnosed it and to have fully described the physical findings upon which a diagnosis could be made. Prior to the advent of x-ray examination and fluoroscopy and before the use of this diagnostic aid had become universally prevalent, there was an absence of case reports on spontaneous pneumothorax. In the last two decades, case reports of non-tuberculous spontaneous pneumothorax began to appear in greater numbers. Of special interest is the increasing number of cases occurring in otherwise apparently healthy individuals without any antecedent history or physical stigmata of tuberculosis or evidence of any other pathologic condition of the lung. These are the so-called idiopathic or essential types of spontaneous pneumothorax.

In reviewing the literature on this subject it is apparent that many observers use the term "spontaneous" in its narrower sense, namely, that in which there is no evident internal or external cause for the pneumothorax. "Spontaneous pneumothorax" embraces all cases whether primary or secondary to pathologic changes, in contradistinction to the artificial or induced pneumothorax. "Idiopathic or essential spontaneous pneumothorax" is the term used in cases in which there is no evident cause for the condition.

ANATOMY

The so-called "lung unit" is the "lobule" (Fig 1). Air enters the lobule through a respiratory bronchiole which is a branch of a larger bronchiole. The respiratory bronchiole leads into several alveolar ducts, each of which branches out into from three to six atria. Each atrium leads into an alveolar sac, which finally ends in the terminal alveoli. Numerous alveoli communicate with one another. However, there are also scattered alveoli along the walls of the respiratory bronchioles. These latter alveoli have a more direct communication with the main bronchi.

The visceral layer of the pleura is very thin and firmly attached to the lung. It is composed of an outer mesothelial layer of flat cells which rests on a thin layer of fibrous tissue, beneath which is a subserous layer of fibrous tissue. Subjacent to this layer are the pulmonary alveoli which, with their blood, nerve, and air supply, compose the lung lobule.

The pleural cavity is the space between the visceral and parietal pleura. Normally it is negligible during a deep inspiration, as the visceral layer glides over the parietal layer. During expiration the space is actual, and varies from one-half to one inch in extent.

The lungs are kept distended by virtue of the negative pressure normally maintained in the pleural cavities. The negative pressure is produced by the elastic recoil of the lungs always tending to collapse, and thus pulling on the semirigid wall of the closed thoracic cavity. Various investigators have estimated this negative pressure to be from -3 to -6 mm during expiration and from -5 to -10 mm of mercury, during inspiration.

¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

Feb 20, 1937—Mantoux test—1 mgm
neg

Oct 29, 1935—Sedimentation Index—6
mm

Dec 9, 1935—Sedimentation Index—2
mm

This case beautifully demonstrates the bleb as the etiological factor of the pneumothorax

REVIEW OF LITERATURE

Osler (1) states that 90 per cent of spontaneous pneumothorax cases are due to tuberculosis, according to S West, that the condition is extremely rare, and that it is almost invariably associated with fluid or pus. Another point Osler makes mention of is that pneumothorax rarely follows fracture of a rib, even though the lung may be torn. He cites one case of pneumothorax developing in a patient of his while going downstairs. No effusion followed and the patient did not react to tuberculin.

Louis Hannon (2) reports five cases, three of which were non-tuberculous as proved by one, three, and five years' follow-up. However, he regards all cases as definitely tuberculous, and due to the rupture of a pleural adhesion into a small peripheral tuberculous focus, closure of which follows lung collapse.

I S Kahn (3) reports a case of idiopathic spontaneous pneumothorax, non-tuberculous. There was a history of asthma, lasting 18 years. The complication occurred while lifting an 80-pound sack of beans, the patient being seized with a sudden discomfort and tightness in the left chest. Cough was a prominent symptom. There was no tendency to re-expansion after nine weeks, so that aspiration of air had to be resorted to. The lung re-expanded completely within a few weeks, following thoracentesis.

F P Weber (4) in discussing spontaneous pneumothorax, states that there are practically 200 cases on record in which this accident has occurred in apparently healthy persons, without obvious exciting cause beyond sudden respiratory effort.

Terry (5) reports a case of spontaneous pneumothorax of uncertain etiology that

had occurred in a young man while taking a cold shower. Return to normal was complete in four weeks.

J B Hawes (6) reports a case of recurrent spontaneous pneumothorax occurring first on one and then on the other side, both apparently non-tuberculous.

Alfred Meyer (7) reports a case of bilateral spontaneous pneumothorax, non-tuberculous, with autopsy, showing extreme emphysema of both lungs. The patient died during a third attack, all had taken place within a period of one year.

A S Hendrie (8) reports a case of traumatic spontaneous pneumothorax occurring in a young football player, following pressure on the chest in a scrimmage. There was another attack, on the opposite side, one week later, during another game.

Leon T LeWald (9) reports a case of spontaneous pneumothorax in a messenger boy 16 years of age, while running an errand. He collapsed in the street suddenly, complaining of pain in the right chest and was taken to a hospital, remaining there one day. Diagnosis was unsolved until three weeks later, when a roentgenogram revealed the true nature of his condition. No evidence of active or latent tuberculosis was found, and no history of previous illness. The chest was deflated. Complete expansion of the lung followed in 11 days. LeWald says that in not a single case out of a series of more than 10 cases has there been any evidence of tuberculosis. Seven made prompt recoveries. Two showed persistent pneumothorax. He concludes that spontaneous pneumothorax may occur in a person with healthy lungs and result in complete and permanent recovery.

M R Castex and E S Mazzer (10) say that recurrent benign spontaneous pneumothorax is a result of the tearing of the so-called subpleural blebs, the rupture of which is caused by an exaggerated pressure during an effort. The subpleural blebs form themselves mechanically, at the level of the weaker or slightly altered areas of the lung at the time of gaseous overdistention at that level.

monly in the young Adult males and females are rarely affected No greater exertion than ordinary respiration seems necessary to produce it and the cause, if any, is difficult to find and impossible to prove

Secondary spontaneous pneumothorax is secondary to tuberculosis of lung or pleura or both, the cause of from 60 to 90 per cent of all spontaneous pneumothorax, according to various authors, pathology of any of the organs in the mediastinum or pleura, *e g*, newgrowths of the trachea, esophagus or mediastinum, bronchi or pleura, pneumonia, pertussis, gases formed in the pleural cavity as a result of infection with the *Bacillus aerogenes capsulatus*, attempt at artificial pneumothorax When secondary to pulmonary tuberculosis it is more common in far advanced cases Not infrequently it occurs in minimal cases which have been arrested for many years When partial and localized it is usually in the vicinity of an active focus, and thus by selective collapse aids in the healing of the disease

It is asserted that spontaneous pneumothorax has greatly increased since artificial pneumothorax has been extensively practised Fishberg and Brauer and Spengler state that spontaneous pneumothorax may occur when the needle for artificial pneumothorax causes laceration of the visceral pleura and lung, or when inflation of air causes separation of adherent pleura and thus lacerates the visceral pleura and lung Watterson (14) states this accident occurred only once in 200 paracenteses on 30 patients in his service It is his belief that "coincident rather than resultant rupture of the visceral pleura during artificial pneumothorax is probable in many cases"

In recent literature cases are reported in infancy and childhood, both of the primary and secondary variety, tuberculosis seldom being a factor

THEORIES OF FORMATION

The following hypotheses have been advanced as to the formation and mechan-

ics of idiopathic spontaneous pneumothorax

1 Rupture of a pleural tuberculous focus, at times so small as not to be demonstrable by any of the diagnostic methods at our command

2 Rupture of a pleural adhesion

3 Rupture of an air bubble resulting from emphysematous vesicles or bullae

4 The authors' theory depends on the location of a visceral pleural defect during natural "wear and tear" It is based on the assumption that no matter what the cause of pleural and lung laceration, the location is what determines whether or not pneumothorax takes place The size of the laceration is not a determining factor Osler states that pneumothorax rarely follows fracture of ribs, even though the lung may be torn On the other hand, a very small laceration, if in the proper location, will produce it What constitutes optimum location for the production of pneumothorax? If the tear, be it small or large, involves bronchi, bronchioles, respiratory bronchioles, or even alveoli lining the wall of a respiratory bronchiole (Fig 1), then the atmospheric pressure in the trachea and bronchi by fairly direct communication exerts sufficient force to drive air into the pleural cavity and cause a pneumothorax On the other hand, a laceration may involve numerous intercommunicating alveoli and not produce a pneumothorax This is due to the fact that communication of these alveoli with atmospheric pressure in the trachea and bronchi is very remote and the air pressure in these alveoli is negligible

The authors are of the opinion that in normal respiration the gliding of visceral over parietal pleura causes a continuous shedding and regeneration of the pleural mesothelium A slight defect in the regeneration at some point, if located in a portion of a lung lobule or lobules involving one or more bronchioles referred to above, will, when accompanied by a respiratory effort of greater or lesser severity, cause a tear in the visceral pleura and a pneumothorax will follow Of course the lack of probability

(13) SYCAMORE, L K Recurrent Idiopathic Spontaneous Pneumothorax Am Jour Roentgenol and Rad Ther December 1936 36, 844-848

(14) WATTERSON, W H Deflation of Pleural Cavity in Treatment of Spontaneous Pneumothorax U S Vet Bur Med Bull May 1926

(15) Idem Variations in Intrapleural Pressure as Modified by Pathology U S Vet Bur Med Bull April, 1929 5, 247-254

(16) STEWART H M Spontaneous Pneumothorax with Unusual Features U S Vet Bur Med Bull, March, 1932, 8, 220-222

monly in the young. Adult males and females are rarely affected. No greater exertion than ordinary respiration seems necessary to produce it and the cause, if any, is difficult to find and impossible to prove.

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called *pai-kan*, whereas the city dweller drinks mild rice wine

The relative frequency of esophageal cancer among Japanese men and its possible relation to the consumption of hot Japanese *saki* has been noted by Nagayo

SUMMARY

Statistical comparisons of cancer mortality among the different races may be a source of important information upon the remote causes of cancer

A study of cancer statistics among different races indicates little difference in racial susceptibility to cancer generally, but

marked differences in the incidence of cancer of different organs in the various races

The important question that remains to be answered is whether these differences are due to racial susceptibility, individual susceptibility, or to external factors that are determined by habits and customs. The evidence would seem to favor the view that individual susceptibility may be a more important factor than racial susceptibility. The extent to which these remarkable differences are due to intrinsic factors or to extrinsic factors is a problem for further study and investigation

tion had been marked by continuous retrogression

CASE REPORTS²

Case 1 Male, 30 years of age, had a pulmonary hemorrhage on Aug 15, 1920

occasions, disclosed signs of small healed tuberculous lesions at both apices, corroborated by x-ray examination

The onset of spontaneous pneumothorax was on March 24, 1923, with sudden sharp agonizing pain in the left chest as

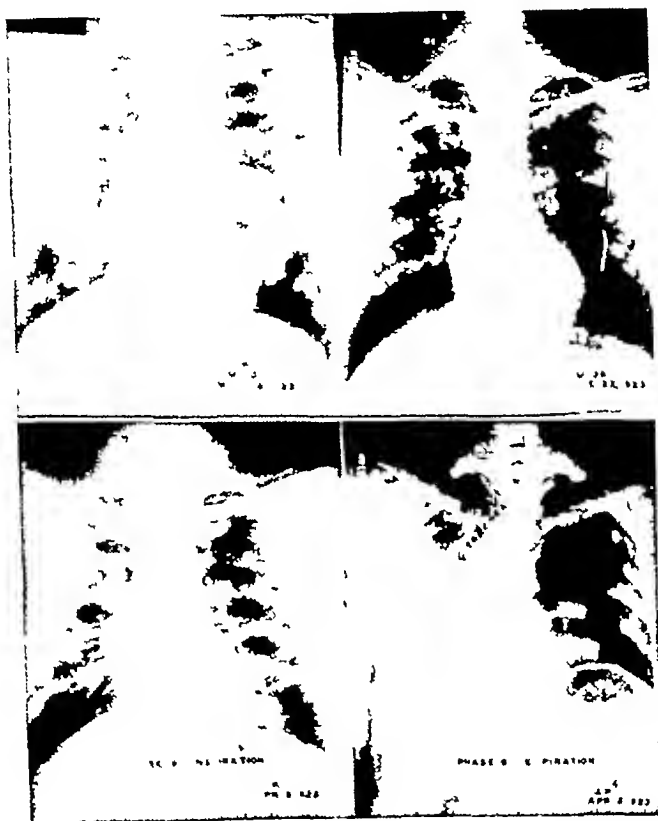


Fig 2-A (top) Case 1 Partial left pneumothorax in outer third of chest with slight shift of the mediastinum

Fig 2-B Complete re-expansion of left lung

Fig 3-A (bottom) Case 1 Partial left pneumothorax during inspiration

Fig 3-B The same during expiration showing exaggeration of pneumothorax and mediastinal deviation

He was treated in private sanatoria and at Veterans' Hospital, New Haven, until July, 1922, when he was discharged as an arrested case. There was also a history of syphilis in 1916, for which he received 29 salvarsan injections and 125 mercury injections. Several blood Wassermann tests in 1921 and 1922 were negative. Examination Jan 3, 1923, as on several previous

the patient was alighting from a subway train. He had to be taken home in a taxi where he remained for two days, suffering from intense pain in the left chest and some dyspnea. He was in bed one week. The symptoms gradually subsided and abated entirely in three weeks.

When seen two days after this onset the patient looked pale, but not acutely ill. He walked slowly, appeared anxious, and favored the left side while walking or moving. Temperature and pulse were

² From (a) U. S. Veterans Administration of New York City. (b) Tuberculosis Clinics of Department of Health, New York City.

associates at the California Institute of Technology, in Pasadena. In the latter part of 1930 a clinical study was begun to determine the effect of very penetrating x-rays on inoperable carcinoma. From the outset we have been interested, not in justifying the use of supervoltage equipment, but in observing its effects on malignant lesions, recognizing that final judgment must be based on therapeutic results.

At the W. K. Kellogg Laboratory, 746 patients with inoperable malignant lesions have been treated since October, 1930. During the last five years we have, in the main, limited our work to deep-seated lesions of the prostate, rectum, bladder, esophagus, kidney, and to advanced carcinoma of the cervix. We have also irradiated cancer of the pharynx, larynx, breast, and testicle. With very rare exceptions, diagnoses were confirmed by biopsy. In the cases with fatal termination 80 per cent of autopsies have been obtained and this has been of great importance to an understanding of results.

At the time we started our work, no therapy with supervoltage had been attempted, and it was, therefore, considered desirable to proceed very cautiously, closely observing the effect on the patient's general condition, the skin, the subcutaneous tissues, irradiated organs, and adjacent structures as well as on the lesion itself. During the first two years the large majority of patients accepted had very advanced lesions and in many instances these patients had previously received unsuccessful treatment with radium, x-rays, or both. Small cycles of treatment were administered at intervals. Only a few of these patients are now living, but the observations made during their lifetimes and the findings at autopsy indicated to us that in all probability the doses used had been inadequate and that higher doses and increased treatment rate should be tried.

In order to reach a high total depth dose in supervoltage treatment it is necessary to employ field sizes which will include the

entire tumor and to cross-fire this region from as many fields as can be satisfactorily utilized on the skin. Our present treatment factors are 900 kv, 3 ma, 6 mm steel plus 1 mm lead filter, 58 cm target-skin distance, intensity 15 r per minute as measured by a standard air chamber. This quality of radiation is characterized by a half value layer of 6.5 cm of water or 8.1 mm of copper.

Up to October, 1936, 161 cases of carcinoma of the cervix have been irradiated, 93 per cent of these patients being classified in Groups III and IV (Schmitz) or as victims of post-operative recurrence. All cases were accepted for treatment if they were not terminally cachectic, if they showed no definite evidence of distant metastases, and if there was no gross ulceration of the bladder wall. Many of these patients had far advanced cancer, but were taken for whatever palliation could be achieved. Preferably a single cycle of treatment was given through from six to eight 10×15 cm portals and usually at a daily treatment rate of 300 r over one field. The total dose varied between 10,000 and 20,000 r as measured in air. Individualization of the treatment plan in each case is required and depends not only on the patient's general condition, but also on the skin effect and on the reaction of the organs and tissues immediately adjacent to the tumor. With this method we have rarely seen dangerous complications or serious sequelae. In a small group of patients, with the hope of improving our results, a treatment technique which provided a higher total dose and a greater daily intensity was employed. However, we do not feel that such intensive treatment is warranted since we have seen irreparable damage to the bladder and rectal mucosa, even though there was no striking cutaneous reaction. The primary regression in mid- and late-stage cervical carcinoma has been very encouraging. All of the post-operative cases and roughly half of our other cervix patients have been treated by supervoltage x-rays alone, the balance by supervoltage supplemented

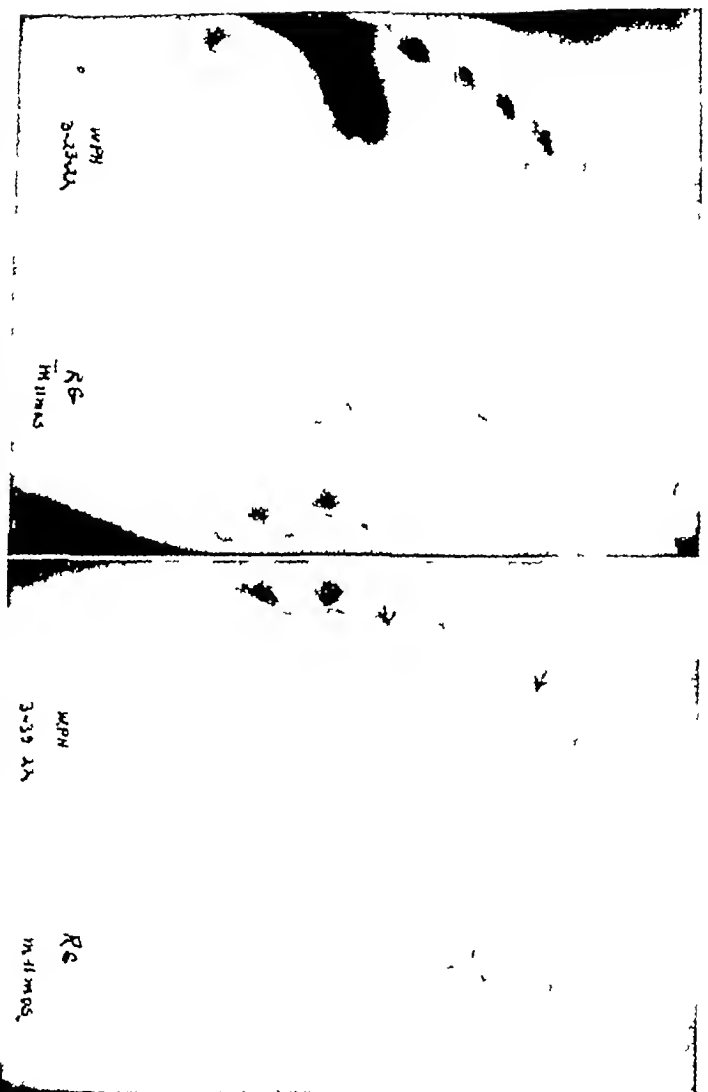


Fig 7 (left) Case 4 Consolidation of entire left chest with complete pneumothorax
Fig 8 (right) Case 4 One week later resolution in solidified lung with no change in the pneumo-
thorax

borne in mind that the struggle against death is not concerned with carcinoma alone, for allied with death are all the forces which accompany senility

In the main, results in bladder carcinoma have not been reassuring

In rectal carcinoma also the results have been disappointing In general, we have not observed much permanent benefit in rare instances a fixed lesion has shown marked regression and has been rendered operable In some cases worthwhile palliation was achieved, as evidenced by occasional reduction of growth and cessation of hemorrhage

Renal tumors have done well In two out of six cases of Wilms' type, regression was so marked that nephrectomy was easily performed These two patients are alive and well Out of eight cases of post-operative hypernephroma in which tumor tissue remained in the renal vein, four show no evidence of malignancy following supervoltage therapy

Palliation for varying periods of time has been observed in esophageal cases Few patients in this group have survived more than one year, and none for two years

In testicular cases we have irradiated not only the site of the primary tumor, but also the lymphatic channels through which the disease commonly spreads Except

in a few patients who had resistant lesions, the results have been encouraging, even though distant metastases were present in a few patients at the inception of treatment

Our observations thus far in mid- and late stages of cancer of the breast lead us to believe that there is little or no additional advantage in supervoltage therapy as against adequate irradiation with 200 kv

In the x-ray treatment of carcinoma of the larynx and pharynx, Coutard has pointed the way, and although quite comparable results in certain cases can be attained with supervoltage, it would seem that 200 kv irradiation provides sufficient ionization in the tumor-bearing regions involved

It is obvious that it is too early to draw final conclusions regarding supervoltage irradiation Fortunately, therapy of this type is being carried on in a number of laboratories in this country and abroad It is to be hoped that co-operation between these clinics will result in a better understanding of the proper use of this agent.

REFERENCES

- (1) LAURITSEN C, and BENNETT R D A New High Potential X ray Tube *Physical Review*, 1928, 32, 850-857
 - (2) LAURITSEN C, and CASSEN B High Potential X ray Tube *Physical Review* 1930 36, 988-992
-

diminished fremitus, hyperresonance and absent breath sounds over the left lung. The apex beat of the heart was pushed 2 or 2.5 inches to the right. The right lung showed harsh breathing with a few scattered sibilant râles. X-ray and fluoroscopic examinations the following day showed a complete left-sided spontaneous pneumothorax, with moderate displacement of the heart and mediastinum (Fig 9).

Re-expansion and clinical convalescence were slow. It took two months for complete recovery. During this observation period there were no symptoms or signs of tuberculosis. The treatment was symptomatic, including a one-month sojourn in the mountains.

On Feb 1, 1930, while taking a shower, he experienced a similar attack of pain. The history of this attack varied but little from the other two. The physical examination at this time showed a three-quarters collapse, with definite evidence

of thickening of the left pleura and a wide pleural adhesive band extending from the hilum of the lung. There was no evidence of pulmonary tuberculosis. Following this episode he was under my observation, reporting regularly once a month. He has remained in fairly good health to date, aside from an asthmatic-bronchitic condition which is of long standing.

Case 6. This is a case in which re-expansion of the lung failed to take place. This patient is a man, 49 years of age, in the bonding business. He has had three attacks of pleuro-pneumonia in the previous ten years, with a chronic cough and wheezing in the chest for many years. No history of tuberculosis was elicited.

On Oct 17, 1930, while walking, he was suddenly seized with a sharp, lancinating pain in the left chest, with marked shortness of breath. He collapsed and was taken to Bellevue Hospital by ambulance. He remained there 15 days, receiving symptomatic treatment only.

Physical examination on Nov 2, 1930,

screens with ordinary good contact, hardnesses 50 kv peak and 80 kv peak, both through 2 mm Al, unsharpnesses from 0

On calculating the profiles of these shadows, it was striking how little injury was done by small degrees of unsharpness



Fig 1 Visibility of a thin narrow cone in double screen roentgenograms with varying degrees of unsharpness 50 kv and 80 kv both with 2 mm Al Pair of hardwood sticks 3 mm diameter near one end tapering to 0.5 mm near the other Unsharpnesses of 0, 0.50, 1.0, 2.0, and 3.0 mm Shadows run together where unsharpness is 1.3 times diameter of shadow of stick Increase of object distance in order to increase the sharpness results in magnification Truncated end of cone marked in pencil

to 3 mm The shadows were distinguishable on the original film when

$$U_o < 1.3d \quad (1)$$

Difference between 50 kv and 80 kv was imperceptible

and how rapidly the profile became degraded as soon as unsharpness reached the diameter of the cylinder (Fig 2)

By taking one of these degraded profiles and calculating the effect upon it of a further "dose" of unsharpness, one can



Fig 11 (left) Case 7 Complete left pneumothorax with large emphysematous bleb directly adjacent to it and irregularity of visceral pleural margin overlying emphysematous bleb

Fig 12 (right) Case 7 Ten weeks later Pneumothorax slightly diminished pleural irregularity absent

studies with a concentrated sputum all proved to be negative X-ray examination Oct 14, 1935 (Fig 11), showed a partial left pneumothorax with fluid in the lower portion of the chest Dec 9, 1935 (Fig 12), there is some re-expansion of the collapsed lung with a rise in the level of the fluid A large, oval area of rarefaction is visualized in the mid-lung field just beneath the visceral pleura The appearance is very suggestive of an emphysematous bleb Jan 20, 1936, the left lung is re-expanding There is thickening of the visceral pleura and fluid at the base The lung re-expansion has increased, the mediastinum is not shifted The right lung appears clear March 16, 1936, no change Aug 11, 1936, the left chest shows slight clouding at the base which is less than previously and due to thickened pleura The lung-fields are otherwise negative Nov 2, 1936, left basal pleuritic thickening and slight displacement of the mediastinum to the left, chest is otherwise negative Feb 25, 1937 (Fig 13), mediastinum still shows a slight shift to the left The left costophrenic sinus is clouded In the mid-portion of the left fourth and fifth interspaces there is noted an irregular lung

translucency which outlines to a much less degree and extent the bleb formation that was so well made out in the original films with the pneumothorax

During the entire observation of the patient in the Health Department Clinic he had no complaints, feeling perfectly well

Jan 4, 1937—Mantoux test—0 1 mgm 1 plus (?)

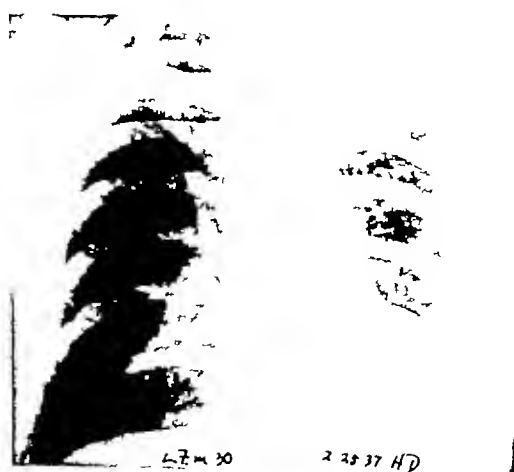


Fig 13 Case 7 Pneumothorax disappeared The emphysematous bleb is present but not clearly delineated

watts per actual mm^2 of focal spot) and for a rotating target (about six times that), and has calculated and plotted the relationship between U_0 and U_m for a thin cylinder of diameter d . Two discrepancies balance within 5 per cent for $\frac{1}{4}$ mm line focus and 1 mm rotating target from $\frac{1}{60}$ sec to $\frac{1}{4}$ sec. I have

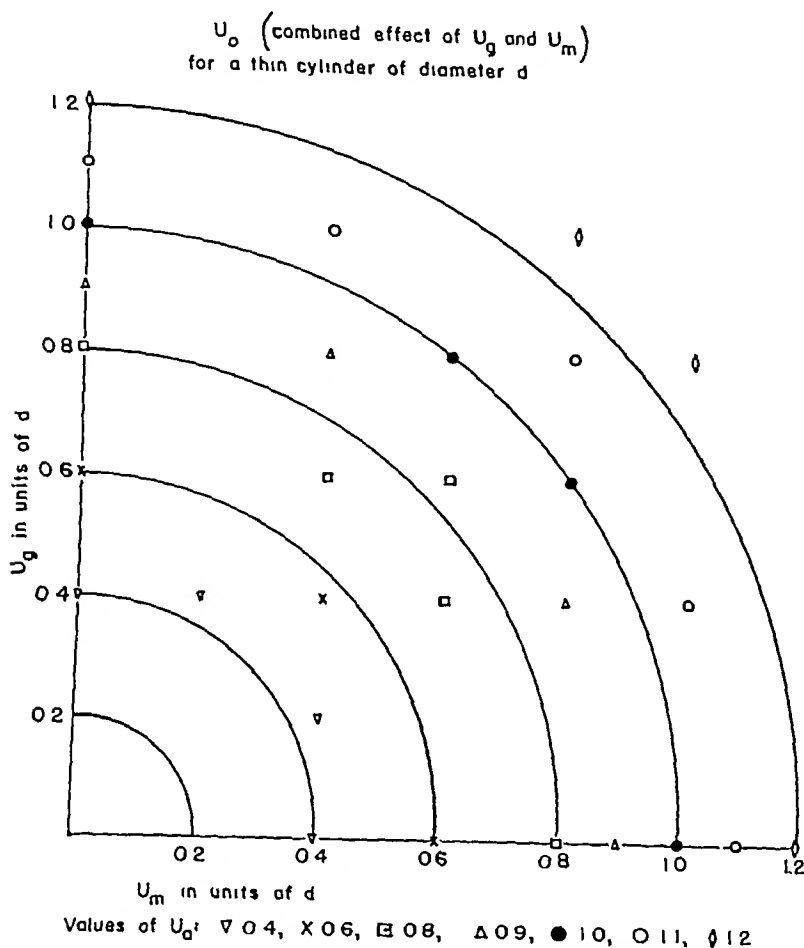


Fig 3 Effective or 'observed' unsharpness of the shadow of a thin cylinder caused by combined action of geometric unsharpness and movement unsharpness. Contours along points of equal observed unsharpness turn out to be circles

tion of exposure time to resultant unsharpness, supposing tube distance fixed (say at 1.5 meters) and choosing a diameter of focal spot just big enough to carry the load. Of course this is not what we do. We take our tube with a given focal spot and change the distance, putting it just as far away as we can and still get a full exposure in the given time with the permitted load. This changes the magnification of unsharpnesses as well as of the whole object. Also, Warren ignored the permission to use slightly heavier loads at very short exposure times. By chance these

taken a slightly heavier loading than Warren took as permissible on rotating anode.

Figure 4 shows how geometric unsharpness increases as one shortens the exposure time and how movement unsharpness increases as one lengthens the exposure time. Adding the two sorts of unsharpness, one observes an optimum exposure time, where total unsharpness is at a minimum. Taking the more accurate evaluation of resultant unsharpness according to Equation 2, one sees that that definition is better than one had thought at first, and that one should choose a slightly different exposure time

A Schick (11) states that Schminker and Kjaegrood hold congenital pulmonary cysts as etiological factors. The rupture of a superficially located cyst gives rise to the pneumothorax. They regard these cysts as developmental congenital anomalies of pulmonary alveoli. The author was able to demonstrate one case clinically and roentgenologically from the clinic of Julius Bauer, of Vienna, of a cyst as the cause of idiopathic spontaneous pneumothorax.

The Editor of "Queries and Minor Notes," *Journal of American Medical Association* (12), makes the following statements: "The most common cause of spontaneous idiopathic pneumothorax is the rupture of an emphysematous vesicle. These vesicles depend on scar tissue involving a bronchiole in such a manner as to produce expiratory obstruction. There results gradual overinflation of the affected lobule with ultimate perforation into the pleural cavity."

L K Sycamore (13) reports a case of recurrent idiopathic spontaneous pneumothorax of the relapsing type with a pronounced tension pneumothorax in one attack. The emphysematous bulla, which was apparently the etiologic factor, was plainly visible on the roentgenogram.

SUMMARY

1 The cases here reported constitute an interesting variety of spontaneous pneumothorax, namely, one idiopathic case, two occurring in the presence of latent minimal tuberculosis, but in otherwise healthy individuals, with no activity following re-expansion of lungs, two secondary to chronic adhesive pleurisy and asthmatic bronchitis, one in an infant complicating lobar pneumonia and one case resulting from an emphysematous bleb demonstrated roentgenologically. One of the series showed three occurrences, two years apart, with complete re-expansion each time, one failed to re-expand seven years following collapse.

2 Spontaneous pneumothorax, essen-

tial, without demonstrable antecedent pulmonary or pleural pathology, is comparatively rare, but that it does occur with greater frequency is no longer doubtful.

3 A plausible theory for the possibility of such an accidental occurrence in a healthy individual with healthy lungs is offered by the authors.

4 Sudden sharp pain accompanied by a choking sensation in one side of the chest are the invariable symptoms, dyspnea is present to a greater or lesser degree, while cough is not a prominent symptom.

5 Fluoroscopy alone is not sufficient to exclude a partial spontaneous pneumothorax. In a suspicious case, roentgenograms during both phases of respiration are necessary. Progress can be definitely checked by serial x-ray examinations.

6 Cases of spontaneous pneumothorax, idiopathic, or those secondary to slight pleural or pulmonary pathology, including healed cases of tuberculosis, all tend to recovery.

7 Treatment is essentially symptomatic. If respiratory distress is pronounced, deflation is resorted to.

REFERENCES

- (1) OSLER SIR WILLIAM. *The Principles and Practice of Medicine*. Eighth ed. pp 669, 670.
- (2) HANNON, LOUIS. Spontaneous Pneumothorax. *Am Jour Med Sci* February, 1916 151, 229.
- (3) KAHN I S. Idiopathic Spontaneous Pneumothorax Apparently Non tuberculous. Report of a Case. *Jour Am Med Assn*, April 14, 1923 80, 1060-1063.
- (4) WEBER, F P. Case of Spontaneous Pneumothorax. *Practitioner*, April 1919, 102, 190.
- (5) TERRY A H. Spontaneous Pneumothorax of Uncertain Etiology. *Jour Am Med Assn* June 3 1916, 66, 1776.
- (6) HAWES J B. Case of Recurrent Bilateral Pneumothorax. *Boston Med and Surg Jour* April 20 1922 186, 528-530.
- (7) MEYER ALFRED. Case of Bilateral Spontaneous Non tuberculous Pneumothorax with Autopsy. *N Y Med Jour* June 30 1917 105, 1235.
- (8) HENDRIE A S. Unusual Case of Pneumothorax. *British Med Jour*, Oct 13, 1923 2, 659.
- (9) LEWALD L T. A Case of Spontaneous Pneumothorax. *Am Atlas of Stereoroentgen* Ser No 65, Ser pp 239 183-185.
- (10) CASTA, M R and MAZZER E S. Recurrent Benign Spontaneous Pneumothorax. *Prensa Medica Argentina* Aug 5 1936 23, 1831-1849.
- (11) SCHICK A. *Wien klin Wchnschr* Oct 9, 1936 4, 1250-1253.
- (12) *Queries and Minor Notes*. *Jour Am Med Assn*, Feb 27, 1937, 9, 751.

Substituting value of area from (5)

$$U_o^2 = \frac{0.132}{k\lambda}$$

If the object is moving 5 mm per sec, allowing for magnification,

$$U_m = 5 \times \frac{200}{200-15} t = 5.4t$$

Substituting this value in Equation (6)

$$\begin{aligned} U_o^2 &= 0.132 \times 7.57\lambda^{1/3}\lambda^{-1} \\ &\quad + 29 \times 0.0173\lambda^{-2/3} \\ &= 1.0\lambda^{-2/3} + 0.5\lambda^{-2/3} \\ U_o &= 1.22\lambda^{-1/3} \end{aligned}$$

(Chantraine has already remarked that sharpness improves only with the third root of the tube loading)

Relation of best attainable sharpness
to load on focal spot

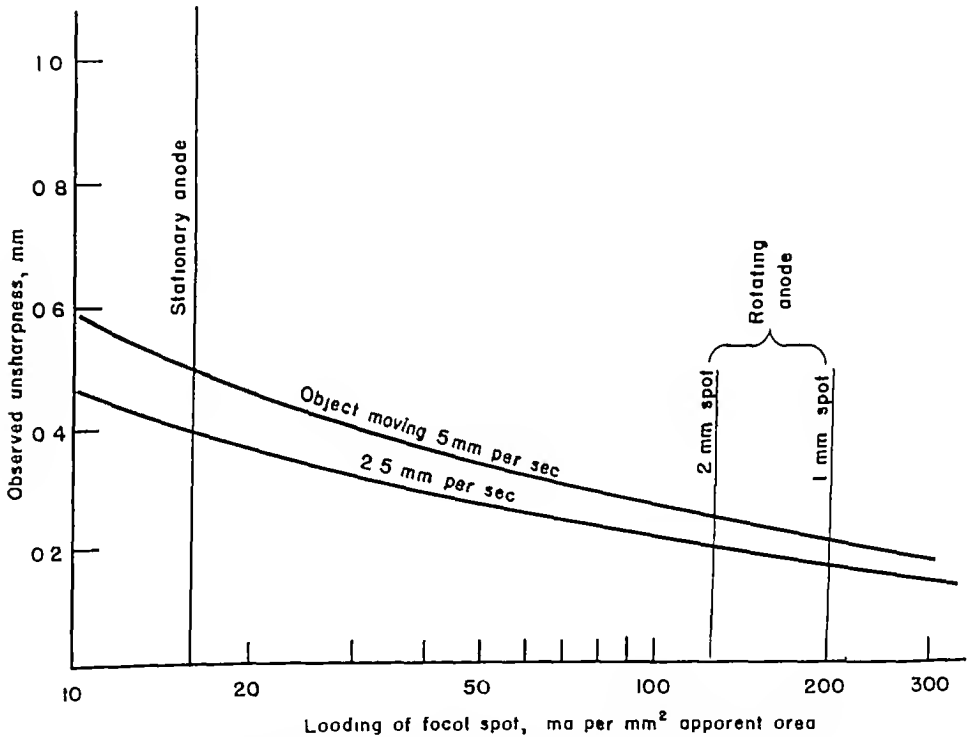


Fig 6 Economics of tube loading. Gradual improvement in best available definition of a moving object as one increases the permitted loading on the focal spot

Then from Equation (2)

$$U_o = \frac{0.132}{k\lambda} + 29t^2 \quad (6)$$

differentiating

$$\frac{dU_o^2}{dt} = -0.132\lambda^{-1}t^{-2} + 58t$$

U_o^2 is at a minimum when

$$\begin{aligned} 58t - 0.132\lambda^{-1}t^{-2} &= 0 \\ t &= 0.132\lambda^{-1/3} * \end{aligned}$$

* That the coefficient is the same as in Equation 6 is a mere accident

If object moves only 2.5 mm per sec, then

$$U_o' = 0.98\lambda^{-1/3}$$

Note also that we have now to amend Bouwers' (1) statement that unsharpness is least when geometric unsharpness is twice movement unsharpness and say instead that

$$U_o \text{ is least when } U_o^2 = 2U_m^2$$

i.e., when $U_o = 1.41U_m$

RACIAL VARIATIONS IN THE INCIDENCE OF CANCER¹

By SIR G. LENTHAL CHEATLE, *London*, and MAX CUTLER, M.D., *Chicago*

THE study of the racial incidence of this disease creates an enormous interest in the clinical side of the investigation into the processes of cancer. To such an extent is this interest stimulated that it rivals the importance of laboratory experiments. Moreover, the possibility of preventing the disease looms large in the study of its racial incidence.

The whole question of racial incidence is crying out for general, specific, and more detailed investigation. In Great Britain alone, for example, although the general incidence of cancer is fairly well estimated, there are still gaps in our information concerning Scotland, Ireland, and Wales, in England itself there are races of different descent.

Besides an inquiry into the racial relation of a cancer patient, the reports of the racial incidence of cancer would be enhanced if the family history in relation to cancer were included in the report of each individual. The question of the importance of the family history of each patient has been raised by Waaler, of Norway. With great care, determination, and accuracy he has conducted an inquiry into the family histories of sisters suffering from cancer. He proved the hereditary influence to his own satisfaction in 30 per cent in some districts and in 70 per cent in others.

A combination of racial and individual family histories of every person suffering from cancer would be highly instructive and would add to the value of racial connections. One of us (G. L. C.) tried in London in a very humble way to elicit family histories in his cases of cancer of the breast. In going into the matter, he found that he would require a staff of tactful and skillful inquirers of such large and expensive proportions that the investigation by a single person, for this and many

other reasons with which we need not trouble this meeting, was rendered out of the question.

In the time and space allotted to us, and for lack of specific information, it is impossible to make our survey as complete as it will be at some future time. For example, a racial survey of cancer in Great Britain cannot be complete until the incidence of the disease can be observed in Ireland, Scotland, Wales, and England. In some parts of England the races can be traced back to Saxons, Danes, and Normans. In America, races are very mixed in places and in others they are segregated. Obviously, the racial incidence of cancer would be purer in the areas where races are segregated than in those parts where the races are mixed. Although Jews live in areas where they are mixed with Gentiles, they remain a fairly pure race. Their family histories, therefore, would be of importance in any country. It would be interesting to discover whether their environments in the different countries in which they live make any difference in the incidence of cancer among them.

There are, however, some interesting facts which emerge from the study of the racial incidence of cancer. The coolies in Sumatra, for example, are either Javanese or Chinese—both live under similar social and climatic conditions and do not intermarry. It has been found that the total mortality from cancer among the coolies is about as high as among corresponding age groups in Holland, and it is not very different for Javanese and Chinese. The organ incidence, however, shows extraordinary variations. The most frequent form of cancer among the coolies is a primary liver-cell cancer (not bile duct cancer), which is almost always associated with cirrhosis of the liver, a type of cancer which is extremely rare among Europeans. Next in frequency among the Chinese is

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

THE RÔLE OF PERIRENAL INJECTIONS OF GAS IN THE RADIOLOGICAL STUDY OF THE ADRENAL GLANDS¹

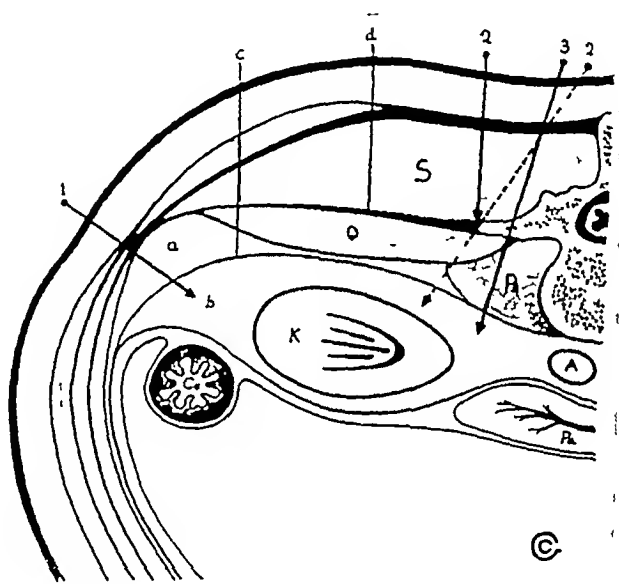
By CESARE GIANTURCO, M D , and CHARLES H DRENCKHAHN, M D , Urbana, Ill

From Sections on Roentgenology and Internal Medicine, Carle Hospital Clinic

PERIRENAL air injections for better roentgen visualization of the kidneys were used as early as 1921 by Carelli, but only recently Cahill and his associates reported the use of this method for the

TECHNIC

A number of technics were described in the early 1920's for the perirenal injection of gas. From a review of the literature it seems that the original method of Carelli



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Fig 1 Cross-section of body at level of the second lumbar vertebra 1 Method of Chevassu and Maingot, 2 Method of Morel-Kahn 3 Method of Carelli a Pararenal space, b Perirenal space c Zuckerhandl fascia, d Quad lumbaris fascia S Sacrospinalis muscle P Psoas muscle, K Kidney, Q Quad lumbaris muscle, Pa Pancreas, Co Colon, and A Aorta

visualization of the adrenal glands. In our opinion this technic is a very valuable one because it often eliminates the danger connected with surgical exploration of the adrenal regions. In this paper we shall attempt to present our own experience with the method and the diagnostic results obtained.

did not give as satisfactory results as the methods described later by Chevassu and Maingot, by Soubiran, and by Morel-Kahn. A study of a cross-section of the body at the level of the second lumbar (Fig 1) will easily explain why no single method can be expected to give 100 per cent results. Regardless of the technic followed, the injection must be made at a great depth and into a very small space. We have used

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept 13-17 1937

CLINICAL OBSERVATIONS IN THE TREATMENT OF CANCER BY SUPERVOLTAGE X-RAYS¹

By SEELEY G. MUDD, M.D., CLYDE K. EMERY, M.D., and LEO M. LEVI, M.D.,
Pasadena, California

From the W. K. Kellogg Laboratory, California Institute of Technology

THEORETICAL considerations make it reasonable to expect that supervoltage x-rays provide a much greater depth dose than is obtained by the use of 200 kv x-rays (at from 50 to 70 cm T.S.D.) or by the radium bomb as employed therapeutically at a much shorter distance from the skin (6 to 10 cm.)

The initial outlay for supervoltage equipment is approximately five times that of 200 kv apparatus, and consequently therapy costs, *r* for *r*, are higher than with 200 kv. However, supervoltage has four (and possibly five) advantages over 200 kv in the treatment of deep-seated lesions

- (1) Increase of skin tolerance—based on the dosage measured with a standard air chamber
- (2) Greater penetration of the beam itself—providing intrinsically a greater depth dose at ten or more centimeters
- (3) Relative independence of depth dose on portal dimensions, thus permitting the selection of multiple therapeutic fields of just sufficient size to include the volume to be irradiated. The skin area in this way can be used to greater advantage and irradiation of tissues and organs adjacent to the tumor minimized
- (4) The more uniform distribution of radiation at 10 cm depth
- (5) The possible existence, suggested by some workers, of a biological advantage due to wave length

Considering both treatment and equipment costs, 200 kv is extremely practical. Treatment can be had at moderate cost

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1938

and present-day equipment, providing high intensities, is mechanically very satisfactory and this type of radiation is much more effectively employed to-day than five or ten years ago. It would be a serious economic waste if 200 kv equipment were replaced, even in part, by supervoltage equipment unless the latter is judged by clinical performance to be far superior. It is a comparatively new modality with which to combat cancer, and its appropriate use and limitations are still being investigated.

There are only a few centers in the world where a radium bomb is available. Under the existing limitations of intensity, treatment time is prolonged and in consequence the number of patients who can receive therapy of this type is relatively small. Moreover, the high price of the bomb makes treatment very expensive. If unquestioned advantage is finally attributed to the very short wave lengths characteristic of radium bomb treatment, then a quite comparable quality of radiation can be obtained by building x-ray equipment to operate at higher voltages than are now used. Supervoltage has four advantages over the radium bomb as it is commonly employed in therapy: (1) greater depth dose, (2) much greater intensity, (3) far more flexibility, since the size of the field and the rate of treatment can be varied within wide limits, (4) lower cost of treatment because supervoltage tubes can be constructed for only one-fourth to one-fifth of the cost of the five-gram radium bomb, and because these tubes can be designed to treat from two to four patients simultaneously.

The first x-ray equipment to be operated at potentials over 300 kv was constructed in 1928 by Lauritsen (1,2) and his



Fig 2 Normal adrenal glands visualized by perirenal injection of gas



Fig 3 Appearance of gas in psoas muscle

years 1920 to 1924. It is obvious, however, that the procedure should be used only when there is a sufficiently strong suspicion of adrenal pathology and when objective evidence cannot be obtained by ordinary clinical means.

After a satisfactory injection has been accomplished, the adrenal glands should be studied with roentgenograms taken in the anteroposterior, postero-anterior, and oblique positions, with Bucky grid, in apnea, with exposures not exceeding two seconds. Normal adrenal glands (Fig 2) will resemble small phrygian caps over the upper poles of the kidney, the average normal size being 3 by 4 cm. Hypertrophy of the adrenals and tumors will be outlined with varying clarity against the dark background of the surrounding gas.

CASE REPORTS

Case 1 A white, unmarried male, 22 years of age, was admitted to the Clinic on Nov. 2, 1936, complaining of "attacks" since August, 1936. He had had these "attacks" for a period of two months, and he also had had these "attacks" for a

period of two months two years previously. At that time they were apparently relieved by the extraction of infected wisdom teeth. The "attacks" consisted of a weak feeling over the heart, heavy forceful beating of the heart, nausea, and a "splitting" headache. They occurred at night and usually awakened him from sleep. They seemed to be dependent on nervous strain during the previous day. Each "attack" lasted from five to ten minutes.

Routine examination and x-rays were negative. X-rays following air injection (Fig 4) showed a round tumor 12 cm in diameter in the region of the right adrenal. Injections of from 4 to 6 minims of adrenalin intravenously provoked an identical attack in one minute. The blood pressure rose to 220/120, and in from five to eight minutes the blood pressure was normal, and the attack was over. The experiment was done both pre- and post-operatively. On Jan. 8, 1937, a large benign paraganglioma was removed from the site of the right adrenal. There have been no attacks since the removal of the tumor.

Case 2 A white, married female, 50

with radium. However, in general we prefer the combined method. Of 42 patients in Group III, 19 (45 per cent) are alive with no definite evidence of disease, out of 86 in Group IV, 18 (21 per cent) are living and apparently well, and of 22 post-operative recurrences, six (27.1 per cent) are clinically free of disease. Our patients post-date treatment from one to four years. These results include 25 Stage III and Stage IV (Schmütz) cases with a residual fibrosis of the broad ligaments which after repeated pelvic examinations, over at least a year's time, reveal no definite evidence of malignancy. It is only too clear that the follow-up period is inadequate and that a number of recurrences are to be expected. These data are included as an interim report for the purpose of indicating the immediate effects of supervoltage irradiation. Radiation sickness is uncommon but if the patient's general condition is poor at the start, treatment is not well tolerated. Maintenance of a patient's weight is important. Watery diarrhea and mild cystitis are frequently noted at the conclusion of the pelvic cycle. While during treatment many of these patients develop a marked erythema, with or without vesiculation in the perineum and in the intergluteal fold, the cutaneous reaction subsides within a few weeks without noteworthy sequelæ. Contraction of the upper vagina and telangiectasia over the cervical mucosa are occasionally seen. Cystoscopic examination in a few patients several months after a pelvic cycle has shown moderate telangiectasia and contraction of the bladder mucosa.

By the use of two small ionization chambers we have determined what we believe to be the most serviceable portals in telerradiation for cervical carcinoma. One of the ionization chambers is placed at the center of the portal of entry of the beam and the other within the posterior vaginal fornix. By this means it is also possible to make sure that patients are properly set up for treatment. Of course, the ionization chamber readings vary in patients of different weights and physical

habitus. In a woman 5 feet 4 inches in height, weighing 140 pounds, the intensity in the posterior vagina was 38 per cent of the dose applied to the anterior pubic field, 48 per cent of the dose over the perineal portal, 48 per cent of the dose at the coccygeal field, and 38 per cent of the dose applied over the sacral portal. Four 10×15 cm fields were used, the longer dimension across the pelvis. When 10×10 or 10×15 cm lateral portals were used the intensity in the posterior fornix was 25 per cent.

Up to October, 1936, 104 cases of proven carcinoma of the prostate have been irradiated. In a large number of these, there has been regression of the local lesion. The prostate becomes softer, smaller, and less nodular, occasionally the nodules disappear. In these lesions regression takes place slowly and it is sometimes a number of months before any improvement is noted. The general condition of the patient has usually remained satisfactory under treatment, but if troublesome cystitis develops we have found it desirable to discontinue treatment for several weeks. Under these circumstances it is then frequently possible, and occasionally desirable, to administer a second cycle of treatment. Since most of these patients have had transurethral resection with relief of urinary obstruction prior to treatment, and since it is well known that unirradiated carcinoma of the prostate is a disease which sometimes progresses slowly, the palliation achieved is difficult to evaluate. However, in our group of cases there has been a change of trend in this disease since noteworthy regression of the local lesion has taken place in over half of all the persons treated. Again as an interim report it may be of interest to note that 38 (36 per cent) of our patients are living, of whom 31 have been free of symptoms for periods varying from one to four years. In only a few cases has subsequent resection been necessary. Patients have died chiefly from metastases. In prostatic malignancy, as well as with cancer in other locations in the aged, it must be

usefulness of this procedure in the diagnosis of adrenal diseases, and report two illustrative cases

BIBLIOGRAPHY

- (1) CAHILL G F Jour Urol September, 1935 34, 238-243
- (2) CAHILL LOEB KURZROA STOUT, SMITH Surg Gynec and Obst February 1936 62, 287-313

- (3) CARELLI, H H Bull et mem Soc med d hôp de Paris, 1921, 65, 1409
 - (4) CHEVASSU and MAINGOT Bull de la Soc Fr d'Urologie, 1921 p 342
 - (5) GARTNER, W Ztschr für Kreislaufforschung, 1936 3, 83
 - (6) GESCHICKTER C F Am. Jour Cancer 1935 23, 104-124
 - (7) LACAYO, I Le Radiodiagnostic par les Insufflations Abdominales, Vigot Frères 1923
 - (8) MOREL KAHN Bull off de la Soc Fr d'Electrol et Radiol, 1922 p 30
 - (9) SOUBIRAN Thèse de Toulouse 1922
-

SHARPNESS OF SHADOWS IN RADIOGRAPHY OF THE LUNGS

By R R NEWELL, M D , *San Francisco*

From the Stanford University School of Medicine

ABSTRACT

The author discusses relationship of exposure time to sharpness of x-ray shadow and arrest of movement for radiography of the chest. He uses a new criterion of sharpness, namely, the visibility of the small pulmonary vessels (idealized). He gives relationship between permissible loadings on the focal spot to the degree of sharpness attainable. Unsharpness varies inversely with the cube root of tube loading (ma per mm² apparent focal spot). X-ray tubes with stationary anode are incapable of resolving 0.5 mm pulmonary vessels set 0.25 mm apart and moving 5 mm per second. With present apparatus the best arrest of lung detail moving 5 mm per second is with 1 mm focal spot on a rotating anode, $\frac{1}{40}$ sec., 200 ma. at 1 meter distance. To use 2 mm focal spot, 500 ma., at 2 meters is almost as good, and might be preferred on account of better detail in bones and lesser magnification of heart shadow.

SOON after the Rotalix tube was developed, Bouwers (1) calculated the optimum exposure time to produce the sharpest shadow of a moving object. Warren (2) noted that the unsharpness due to finite size of focal spot and that due to movement are not simply additive as Bouwers had taken them, but that the observed unsharpness is less than the sum of geometric unsharpness and movement unsharpness. He has given graphs of observed unsharpness related to exposure times for two speeds of movement (5 mm per sec and 2.5 mm per sec) and for two permitted focal spot loadings (line focus on a stationary anode and on a rotating anode). And he gives his recommendations for technic in chest radiography based on these calculations.

Both of these authors have considered the shadow of a sharp edge. But fuzziness of a large shadow is not of much importance. Chantraine (3) has given a dictum, "A picture is to be taken as clearer than another if it shows smaller details," with which I agree. He made some experiments with rape seeds and concludes that for visibility on non-screen film an unsharpness of 0.2 mm requires that the object be 11 per cent thicker, for 0.4 mm unsharpness 23 per cent thicker, and for

0.8 mm unsharpness 54 per cent thicker. He notes that the unsharpness of screens is so bad that there is hardly any advantage in going from 0.4 to 0.2 mm unsharpness of shadow.

In the case of the lung, we are dealing with small vessels. Let us consider the shadow of a thin cylinder. The absorption is only a few per cent, so can be taken proportional to the thickness. The center of the shadow is denser than the edges. The profile of the shadow is (proportional to) a semicircle if we have no movement, and the focal spot is a point.

If we move the cylinder under a point focus, or if we hold the cylinder still and use a broad focus, the shadow will be degraded—and in the same way by either mechanism. The new profile can be calculated by summing the shadows cast by each portion (I used tenths) of the target face (or, for movement unsharpness, each portion of exposure time). We can designate these unsharpnesses by the total increase in width of the shadow.

Some preliminary trials convinced me that an astonishing amount of unsharpness is required to obliterate the shadow of a thin cylinder. It seemed promising to try a more delicate test, namely, the ability to see the separation between two thin cylinders separated a short distance. Two long cones were made of lignum vitae (absorption practically identical with that of water). These were 85 mm long and tapered from 3.2 mm diameter at the butt to 0.5 mm at the 82 mm mark. They were tied to a piece of film base so that the separation was everywhere about one-half their diameter. By raising them varying distances above the film and using a large square focal spot (4 mm), their shadows could be given varying degrees of (geometric) unsharpness. Figure 1 shows the result using new Patterson par-speed

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get the resultant geometric plus movement unsharpness on the shadow of a thin cylinder $[U_g = 1 \text{ mm}, U_m = 2 \text{ mm}]$

immediately that circles run satisfactorily close to the contours of this plot, and one can write

$$U_o^2 = U_g^2 + U_m^2 \quad (2)$$

The practical problem is this If one makes the exposure time short to stop

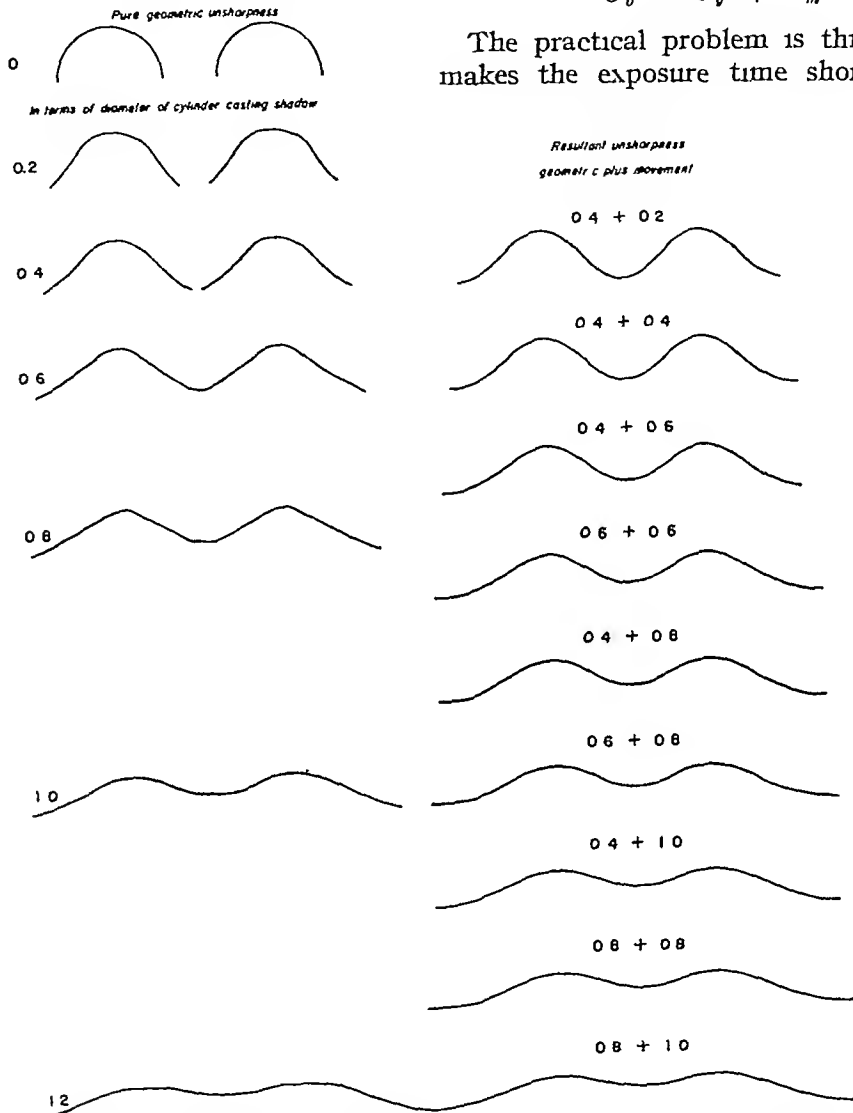


Fig 2 Profiles of roentgen shadows of a thin cylinder under varying degrees and kind of unsharpness

gives, of course, the same effect as

$$[U_g = 2 \text{ mm}, U_m = 1 \text{ mm}]$$

Profiles of the resultants, called U_o , are shown arranged alongside the profiles of the U_g 's which they most nearly match, and which may be used as numerical measures of the U_o 's. Figure 3 shows a plot of U_o against U_g and U_m . It appears

movement, then the focal spot must be made large to carry the heavy current, and U_g will be large. If one makes the focal spot small, then the tube cannot be loaded so heavily and exposure time must be long, making U_m large. What is the best compromise?

Warren has considered the maximum permissible loading for a line focus (250

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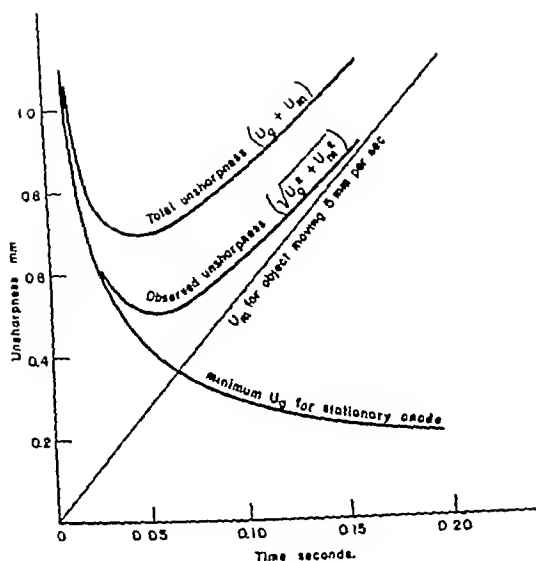


Fig 4

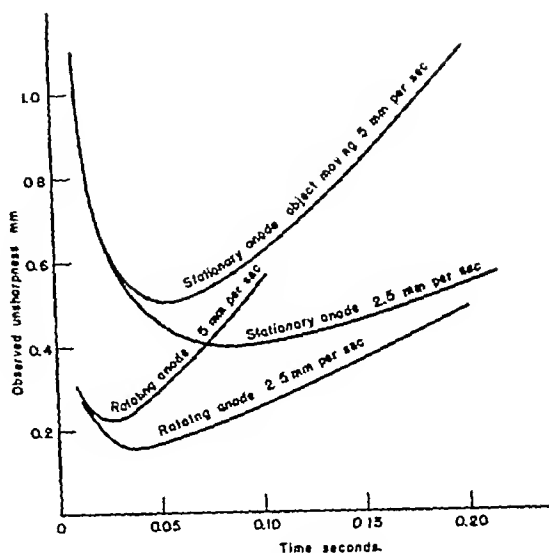


Fig 5

Fig 4 Relation of the two kinds of unsharpness to exposure time, with resultant "observed" unsharpness
Fig 5 'Observed' unsharpness related to exposure time for two tube loadings and two speeds of object. Note that the slower the movement the better the definition and the slower the optimum exposure time

The results will be different for different speeds of movement and for various permitted tube loadings, of course. Figure 5 shows what betterment one can expect by using a rotating anode, or in case the object is moving only 2.5 mm per sec. These are the cases considered by Warren. My calculations point to shorter optimum exposures than his do.

The general relationship of best available definition to permitted tube loading is plotted in Figure 6.

Note that the 2 mm spot on the rotating target is not so good as the 1 mm spot. Just on the basis of sharp lung detail one would always choose the 1 mm spot. Of course, the farther the object from the film and the closer the tube (to get quick exposure), the more conditions favor the larger spot. But only if it is desired to get detail in a moving structure 30 cm from the film and at the same time necessary to set the 1 mm spot as close as 75 cm distance would advantage swing in favor of using the 2 mm spot (at its corresponding longer distance).

CALCULATIONS

It is probably superfluous to repeat the mathematics but a résumé might be in order. Suppose 20 ma-sec is necessary for a satisfactory film with tube at 2 meters. We write

$$ma = \frac{20}{t} \quad (3)$$

If we can load the tube ν ma per mm² of focal spot (apparent area), then

$$area = \frac{ma}{\nu} \quad (4)$$

substituting value of ma from (3)

$$area = \frac{20}{\nu t} \quad (5)$$

Now geometric unsharpness depends on diameter of focal spot and on distance from tube to film and object to film. Considering lung detail 15 cm from film,

$$U_g = \frac{15}{200-15} \times \text{diameter of focal spot},$$

$$U_g^2 = 0.0066 \times \text{area}$$

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

TUMOR CLINICS

The alarming mortality figures for cancer with which statisticians confront us at frequent intervals are indeed disquieting. The enthusiastic physician in intimate contact with all that modern medicine offers the cancer victim finds the situation difficult of comprehension. He knows that the skilled workers with whom he is associated make new inroads on the progress of this disease each year and yet their results seem to have little influence on the statistics of the country as a whole.

A Utopia in which every patient might receive early diagnosis and the most efficient known treatment would unquestionably change these figures for the better, but let us waste no time on Utopian ideals. More can be gained perhaps from a consideration of the opinions of those most concerned. Everyone who works with cancer is prone to place the blame for the low total salvage on someone else.

For instance, the surgeon who sees a patient with a cancer of the lip where insufficient x-ray dosage has been used is convinced that radiologists are standing in the way of progress in cancer therapy. He is likely to be more upset, and justifiably so, when he sees a patient with a cancer of the breast which has become inoperable while receiving inefficient x-ray therapy. In his righteous wrath he does not realize that the individual rather than the method should receive his condemnation.

And, of course, the thing works just as well in reverse. Almost every radiologist must contend with the bold surgeon who ruthlessly attacks every case of inoperable carcinoma with which he comes in contact, thereby becoming a courageous hero who has tried and failed in the eyes of the family. There are also in every community many surgeons who honestly believe that surgery offers the only hope of a cure to patients with cancer of the lip, mouth, throat, and uterus, and advise strenuously against the newer methods with which they are unfamiliar. Obviously little

hope exists for combined methods under such circumstances.

Both the surgeon and the radiologist point frequently to the general practitioner as the offender and in many instances the fault is his, although he usually errs only because of lack of training. The woman from the small town, with uterine hemorrhage treated without an examination for the "change of life," and the man with a tumor of the tongue treated by watchful waiting are tragic examples of this type of inefficiency, all too frequently encountered.

Medical men as a group often feel that the patient himself is the stumbling block because he does not come earlier for treatment. Assuming that he is intelligent enough to suspicion that he has cancer, what does the average layman do? In most instances he first consults a friend, and the chances are that the advice received will be based on one of the quack radio broadcasts or on quack newspaper advertising. Since this type of propaganda, which invariably attacks all efficient methods of treatment, is made available to almost every community and in many instances constitutes the only information at hand, the layman who does not consult a physician really should not be criticized too strenuously.

Obviously many of these difficulties could be ironed out if reliable information about cancer were more widely disseminated in both medical and lay circles. Laymen can hardly be expected to accept methods of treatment which are viewed with suspicion by physicians in whom they have confidence, and the first problem to be met is within the profession itself.

A tumor clinic organized along the lines suggested by the College of Surgeons and made up of competent progressive men who are open-minded and eager to learn from one another can do much to eliminate misconceptions and

Most radiologists have become accustomed to take chest films at 2-meter distance. If one uses the 2 mm focal spot on rotating anode and loads it to its capacity, namely, 500 ma, then at 2 meters the exposure will be $1/24$ sec (i.e., 5 half cycles) and one finds $U_o = 0.16$ mm, $U_m = 0.23$ mm, giving a resultant $U_o = 0.28$ mm. This is not optimal, but is far below what seems to be the critical unsharpness, namely 0.5 mm.

For maximum attainable definition of the pulmonary vessels moving as fast as 5 mm per sec, choose the 1 mm focal spot on rotating anode and give $1/10$ sec (i.e., 3 half cycles) at 1 meter with 200 ma. This gives $U_o = 0.18$ mm and $U_m = 0.15$ mm resultant $U_o = 0.23$ mm.

If 5 ma-sec at 1 meter proves insufficient to give the quality of film desired then a 30 per cent increase in exposure time will still give very sharp shadows,

$U_o = 0.34$ mm for 2-meter distance

$U_o = 0.27$ mm for 1-meter distance

Only a portion of the left lung-field shows rapid movement, so one might wisely choose a longer time and a longer distance when interested in the apices which move but little. If it becomes clinically possible to use "directed exposure" at the moment of diastolic pause, there is about $1/20$ sec available when the heart hardly moves at all. This would permit reduction of U_o

(and U_o) to about 0.11 mm. This brings us down to the order of unsharpness due to film and intensifying screen. I have not investigated these in detail. But if we say their inherent unsharpness is of the order of 0.1 mm (Chantraine says 0.4 mm), and apply Equation 2 here also, then the best definition we can hope for with "directed exposure" during the diastolic pause and a rotating anode tube is a resultant unsharpness of 0.14 mm.

This should be adequate to resolve the shadows of two vessels 0.11 mm in diameter separated 0.06 mm, if only one could get sufficient contrast.

As a matter of fact, present technic gives contrast sufficient only for 0.5 mm vessels, when no contrast is lost by scattering. The rotating anode tube has, therefore, thrown the problem of showing detail in the lung out of the field of movement and geometric unsharpness into the field of preserving and enhancing contrast. Wilsey (4) has made a preliminary report, but no such quantitative study has yet been made as will permit specification of the optimum technic for chest films.

BIBLIOGRAPHY

- (1) BOUWERS A. British Jour Radiol April, 1932, 5, 311-323. Acta Radiol 1931 12, 175-182.
- (2) WARREN, S. R. JR. RADIOLOGY April 1937, 28, 450-465.
- (3) CHANTRAINE H. Fortschr a d Geb d Röntgenstrahlen September 1935 52, 283-292.
- (4) WILSFY, R. B. RADIOLOGY August 1934, 23, 198-201.

Pathology of the Breast Frederick C Narr, M D, Pathologist, Research Hospital
 Benign Lesions of the Breast James E Stowers, M D, F A C S, Attending Surgeon, Research Hospital

Clinical and Roentgenological Data in Brucellosis (Undulant Fever) Fred E Angle, M D, F A C P, Attending Physician, Bethany Hospital
 Discussion—Lewis G Allen, M D



During the meeting of the Midwestern Radiologists in Kansas City February 11 an interview between (left to right) Edward H Skinner M D President of the American Radium Society B R Kirklin, M D President of the American Roentgen Ray Society and W Edward Chamberlain, M D, Chairman of the American Board of Radiology was broadcast over KMBC. The object was to give the radio audience a better understanding of the practical application of radiology

The Visualization and Diagnosis of Breast Lesions by Means of Contrast Roentgenograms N Frederick Hicken, M D, Associate Prof Surgery, Univ of Nebraska College of Medicine, Omaha (by invitation)

The Surgical Treatment of Carcinoma of the Breast Claude J Hunt, M D, F A C S, Attending Surgeon, Research Hospital

The Value of Radiation Treatment of Carcinoma of the Breast Lewis G Allen, M D, F A C R, Prof Clinical Roentgenology, Univ of Kansas School of Medicine

Discussion—E H Skinner, M D

Correlation of Clinical, Encephalographic, and Ventriculographic Findings F R Teachernor, M D, F A C S, Associate Clinical Prof Surgery, Univ of Kansas School of Medicine

Discussion—Galen Tice, M D

Clinical Analysis of Low Back Pain Frank D Dickson, M D, F A C S, Chief Orthopedist, St Luke's Hospital

Discussion—C Edgar Virden, M D, F A C R, Radiologist, St Joseph Hospital

The Problem of Acute Intestinal Obstruction Thomas G Orr, M D, F A C S, Prof Surgery, Univ of Kansas School of Medicine

The Value of the X-ray Examination in Acute Intestinal Obstruction David S Dann, M D, F A C R, Radiologist, Menorah Hospital

Discussion—L W Paul, M D, Radiologist, St Luke's Hospital

Clinical and Roentgenological Features of Endocrine Lesions W M Ketcham, M D, Attending Physician, St Joseph Hospital

Discussion—C Edgar Virden, M D

Clinical and Roentgenological Findings in Trauma of the Genito urinary Tract R Lee Hoffman, M D, Chief Urologist, Research Hospital

Discussion—Ira H Lockwood, M D

Clinical and Radiological Features of Menorrhagia T J Sims, Jr, M D, Associate in Obst and Gynec, Univ of Kansas School of Medicine

the method of Morel-Kahn with slight modifications

The patient should be prepared in the same manner used for an ordinary roentgenogram of the kidneys. We prescribe one ounce of castor oil to be taken the night preceding the examination, and in the morning as many enemas as necessary to clean the colon of gas and fecal material. After cleansing and sterilizing the skin in the lumbar region, with the patient lying prone, two sterile lead markers are placed on the skin on each side and about three centimeters away from the tip of the spinous process of the second lumbar vertebra. A roentgenogram is then taken, which informs us of the position of the transverse processes of the second lumbar in relation to the markers and also of the amount and location of eventual intestinal gas. If an excessive amount of gas is present, every effort should be made to have the patient expel it (pitressin, additional enemas). If the abdomen is free from gaseous collection, one may proceed with the perirenal injection. Under local anesthesia a small opening is made in the skin at a point corresponding to the middle of the transverse process of the second lumbar. Through this opening the anesthesia is extended to the underlying tissue and a blunt² spinal needle is pushed through the sacrospinalis fascia, which offers considerable resistance, and through the underlying muscle until it comes in contact with the transverse process. Once this contact is established the needle must follow the bone to its distal extremity. When the needle slips over the end of the transverse process another resistance is felt while piercing the superficial fascia of the quadriceps lumborum. From this point on, no more appreciable resistances are detectable and the needle should be inserted from 1.5 to 2 cm farther to reach the perirenal space. As one can see from Figure 1, the fat which surrounds the kidney is divided in two spaces by the fascia of Zuckerkindl. In order to avoid

the injection of the space posterior to this fascia, we usually insert the needle deep enough to drive its point into the cortex of the kidney, this means from 2 to 3 cm from the fascia of the quadriceps lumborum. At this point one should withdraw the stylet and aspirate to make sure that the point of the needle is not in a vein and then connect the needle with an ordinary pneumothorax apparatus. A small amount of air is now injected. If the manometer registers respiratory oscillations, one may proceed without further ado to the injection of from 150 to 250 cc of gas. If no oscillations appear, one should withdraw the needle for a short distance, aspirate again, and inject a small amount of air and watch for oscillations of the manometer with respiration or cough. Although some authors do not use this manometric checking of the position of the needle, we feel that it is of great comfort and assistance to the operator. The gas should be injected at a pressure not exceeding 3 cm of mercury. During the injection, no greater discomfort should be experienced by the patient than a sensation of slightly painful fullness. This sensation lasts until the reabsorption of the gas is complete. The time necessary for this reabsorption varies considerably, according to the gas employed. Carbon dioxide is reabsorbed in a few hours, air in three or four days, and oxygen in from 10 to 20 hours. We use ordinary filtered air.

Since the anatomy of the posterior abdominal wall is quite complicated, errors may arise from injecting gas in any of the many fascial compartments. Injections in the psoas muscle are frequent and give the characteristic appearance of "air in muscle" (Fig. 3). Injections in the fat behind Zuckerkindl fascia may give a fair picture of the adrenals, but more often extend upward under the diaphragm and occasionally into the mediastinum. LaCayo reports that Carell produced a pneumoperitoneum in one of his patients.

In spite of the many possibilities of error, no fatal accidents have been reported from the extensive use of this method during the

² The needle must be blunt to feel the resistance of the various layers.

of air per hour than small ones. Air inlets and outlets should be arranged to afford cross-wise ventilation of the room.

6 All rooms should preferably be decorated in light colors.

7 A working temperature of about 18°–22° C (65°–72° F) is desirable in x-ray rooms.

8 X-ray rooms should be large enough to permit a convenient lay-out of the equipment. A minimum floor area of 250 sq ft (25 sq meters) is recommended for x-ray rooms, and 100 sq ft (10 sq meters) for dark rooms. Ceilings should be not less than 11 ft (3.5 meters) high.

9 High tension generators employing mechanical rectification should preferably be placed in a separate room from the x-ray tube.

III X-RAY PROTECTIVE RECOMMENDATIONS

10 An x-ray operator should on no account expose himself to a direct beam of x-rays.

11 An operator should place himself as remote as practicable from the x-ray tube. It should be borne in mind that valve tubes are capable of producing x-rays.

12 The x-ray tube should be self-protected, or otherwise surrounded as completely as possible, with protective material of adequate lead equivalent.¹

13 The following lead equivalents are recommended under average conditions:

X rays generated by peak voltages	Minimum equivalent thickness of lead
Not Exceeding 75 kv	1 mm
100	1.5
125	2
150	2.5
175	3
200	4
250	6
300	9
350	12
400	15
(600)	(35)

(A) *Diagnostic Work*—14 In the case of diagnostic work with other than completely protected tubes, the operator should be afforded additional protection from stray radiation by a screen of a minimum lead equivalent of one millimeter.

15 Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures, particularly when fractures are reduced under x-rays. Palpa-

tion with the hand should be reduced to the minimum.

16 The lead glass of fluorescent screens should have the protective values recommended in Paragraph 13.

17 In the case of screening stands, the fluorescent screen should, if necessary, be provided with a protective "surround," so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm.

18 Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient.

19 Protective gloves, which should be suitably lined with fabric or other material, should have a protective value not less than one-third millimeter lead throughout both back and front (including fingers and wrist). Protective aprons should have a minimum lead value of one-half millimeter.

(B) *Treatment*—20 In the case of x-ray treatment, the operator is best stationed completely outside the x-ray room behind a protective wall, the lead equivalent of which will depend on the circumstances. In the case of a single x-ray tube excited by voltages up to 200 kv, the protective wall should have a minimum lead equivalent of two millimeters. This figure should be increased in the case of higher exciting voltages or of heavy tube currents or if the protective value of the x-ray tube enclosure falls short of the value given in Paragraph 13. In such event the remaining walls, floor, and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances. Full protection should be provided in all those directions in which the direct beam can operate.

Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall.

21 In those cases in which an x-ray tube is continuously excited and treatment periods are regulated by means of a shutter, some form of remote control should be provided for the shutter, to ensure that the operator is not exposed to direct radiation while manipulating the shutter or filter.

22 Efficient safeguards should be adopted to avoid the omission of a metal filter in x-ray treatment, for example, by an interlocking device or by continuously measuring the emergent

¹ The lead equivalent of a given thickness of protective material is that thickness of lead which is equally opaque to x-rays excited at some specified peak voltage.

the method of Morel-Kahn with slight modifications

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In spite of the many possibilities of error, no fatal accidents have been reported from the extensive use of this method during the

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radium, a screen of not less than 2.5 centimeters of lead should be used, and proximity to the radium should occur only during actual work, and for as short a time as possible.

35 The measurement room should be a separate room, and it should preferably contain the radium only during its actual measurement.

36 Nurses and attendants should not remain in the same room as patients undergoing radium treatment with quantities exceeding one-half gramme.

37 All unskilled work, or work which can be learned in a short period of time, should preferably be carried out by temporary workers, who should be engaged on such work for periods not exceeding six months. This applies especially to nurses and those engaged in "making up" applicators.

38 Radium containers should be tested periodically for leakage of radon. Prejudicial quantities of radon may otherwise accumulate in radium safes, etc., containing a number of leaky containers.

39 Discretion should be exercised in transmitting radium salts by post. In the case of small quantities (less than 10 mg of radium element) it is recommended that the container should be lined throughout with lead not less than three millimeters thick, while for quantities between 10 and 50 mg of radium element, the lead container should be supported in the center of a box with a minimum dimension of 30 cm. Packages containing more than 50 mg of radium element are preferably sent by rail or hand under suitable conditions of protection.

(B) *Radon*.—40 In the manipulation of radon, protection against beta and gamma rays is required, and automatic or remote controls are desirable.

41 The handling of radon should be carried out, as far as possible, during its relatively inactive state.

42 Precautions should be taken against excessive gas pressures in radon plants. The escape of radon should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan controlled from outside the room.

43 Where radon is likely to come in direct contact with the fingers, thin rubber gloves should be worn to avoid contamination of the hands with active deposit. Otherwise, the protective measures recommended for radium salts should be carried out.

44 The pumping room should preferably be contained in a separate building. The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect people working in adjacent rooms. This is preferably done by placing the radium solution in a lead-lined box, the thickness of lead recommended being according to the table in Paragraph 32.

(C) *Radium-beam Therapy*.—45 The risks to the operator attendant on the use of large quantities of radium in radium-beam therapy may be largely obviated if some system of remote control is adopted by which the radium is only introduced into the "bomb" after the latter has been adjusted in position on the patient. If such arrangements are not available, the importance of expeditious handling is stressed.

46 Rooms used for radium-beam therapy should provide adequate protection for adjacent wards and rooms in permanent occupation.

The following minimum lead thicknesses are required to secure a tolerance dosage rate of 10^{-5} roentgen per second at various distances from different quantities of radium.

Quantity of Radium Element (0.5 mm Pt screen)	Thickness of Lead to Give Tolerance Dosage Rate at the Following Distances from Radium Source				Tolerance Distance with No Lead
	50 cm	1 meter	2 meters	5 meters	
gm	cm	cm	cm	cm	meters
1	9.0	6.0	3.0		4.5
2	10.5	7.5	4.5	1.0	6.5
5	12.5	9.5	6.5	2.5	10.5
10	14.0	11.0	8.0	4.0	14.5



Fig 4 Case 1 Large paraganglioma of the right adrenal gland



Fig 5 Case 2 Hypertrophy of the left adrenal gland

years of age, was admitted to the Clinic on May 20, 1937. The patient had had a normal pregnancy at the age of 23. She noticed hirsutism and obesity at the age of 25. The menses were regular but scanty. The menopause had occurred two years before admission. Since then, she had had "peculiar spells" at night, occurring at any time from 10 P.M. to 2 A.M. They consisted of upper abdominal pains followed by a crowded feeling in the sub-sternal region, weakness, and cyanosis. She had no idea whether her pulse was fast or slow during the spells. They lasted from a few minutes to a half-hour and were relieved by nitroglycerine. She was never seen by a doctor during an attack.

Examination showed the height to be 5 feet 4 inches, the weight 209 pounds. She had a "buffalo type" of obesity. There was a marked hirsutism of the face, and she had coarse hair on the chest, abdomen, legs and arms. The blood pressure was 135/85. X-rays of the chest, stomach, gall bladder, and head were all negative. X-rays of the adrenals after air injection (Fig 5) showed a marked enlargement of the left adrenal shadow. Glucose tolerance showed a positive dia-

betic curve. The metabolism test was minus 7 per cent. The electrocardiograph showed a rate of 70, sinus rhythm, left ventricular preponderance and diphasic T wave in lead III.

In Case 1 the clinical symptoms pointed to an adrenal disturbance of the medullary type, with sudden discharges of large amounts of adrenalin.

In Case 2 the clinical picture was complicated by cardiac manifestations and diabetes, but the peculiar type of obesity and the marked hypertrichosis made us consider a basophilic adenoma of the pituitary or an adrenal disturbance of cortical origin. In both cases the objective evidence of pathology of the adrenal glands was easily obtained by means of perirenal air injections.

CONCLUSIONS

We believe that the perirenal injection of gas constitutes a valuable method for the objective demonstration of adrenal pathology.

SUMMARY

The authors describe in detail the technique of perirenal injection of gas, discuss the

The monograph is well illustrated and the material well presented. The material addition to our understanding of the various peculiarities and lesions of epiphyses makes the monograph well worth while.

II CONGRES INTERNATIONAL DE LUTTE SCIENTIFIQUE ET SOCIALE CONTRE LE CANCER (Second International Congress of Scientific and Social Campaign against Cancer), Brussels, Sept 20-26, 1936, sous le Haut Patronage de S. M. le Roi et de S. M. la Reine Elisabeth. Tome II, Communications. A volume of 628 pages, with numerous figures and tables in the text. Published by Ligue Nationale Belge contre le Cancer, Brussels, 1937.

This volume, like the first, is published in the same style as the "Acta" of the International Union against Cancer and contains the communications made at the Second International Congress of Scientific and Social Campaign against Cancer, each presented in the language of the author (English, French, German, Italian, Spanish, and Russian). No paper in this volume is in Russian. There are 230 pages on the biologic and 60 on the diagnostic aspects of cancer. 192 pages are devoted to treatment by surgical, radiologic, and medical means. The various aspects of the campaign against cancer are covered in 137 pages.

It is obviously impossible to critically review this volume of several hundred papers of varying length. Even a casual perusal of the book, however, will acquaint one with the up-to-date views of the various aspects of cancer which are held by international authorities.

THE 1937 YEAR BOOK OF RADIOLOGY. Diagnosis edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University, Assistant Visiting Roentgenologist, Johns Hopkins Hospital. Associate Editor, WHITMER B. FIOR, M.D., Assistant in Roentgenology, Johns Hopkins University and Hospital. Therapeutics edited by IRA I. KAPLAN, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York, Clinical Professor of Surgery, New York University Medical College, Director, Radiation Therapy Department, Bellevue Hospital, New York City, Director, New York City and Brooklyn Cancer Institutes, Associate Radiolo-

gist, Lenox Hill Hospital, New York City. A volume of 503 pages containing 550 illustrations. Published by The Year Book Publishers, Inc., Chicago, 1937. Price \$4.50.

In the quest for a reference volume which will be of practical value in the identification of the inevitable "puzzle" of every practice there is no more comprehensive and useful volume than the Year Book of Radiology.

The 1937 edition fully maintains the reputation of former volumes. To those whose practice embraces what might be termed "industrial roentgenology" the chapter on the osseous system is particularly interesting because of its review of fractures of various types and the most efficient methods of treatment.

The momentous question of "low back pain" is brought up to date by inclusion of articles on lumbosacral lesions and roentgen demonstration of rupture of the intervertebral disk into the spinal canal.

The rarer forms of bone and joint lesions are particularly well covered by a series of excellent illustrations and well chosen text.

The chapter on skull, sinuses, and mastoids is particularly interesting to those closely associated with ophthalmologists in the study of neurologic lesions.

In considerations of soft tissue lesions the essays on "painful shoulder" and the roentgen diagnosis of carcinoma of the breast are particularly interesting.

The application of kymography to the study of respiratory movements of the thoracic structures and additional uses of bronchoscopy are outstanding features of the chapter on the respiratory system. The practical application of kymographic studies of cardiac conditions will stimulate interest in this comparatively new method.

Choledochographic studies of the biliary system are comprehensively reviewed in the chapter on the gastro-intestinal system.

Articles on the value of pitressin in the elimination of intestinal gas shadows in roentgenography will have particular interest to many.

Slightly less than half of this volume is allotted to radiotherapeutics. In an introduction to this section a discussion of the cancer problem as a whole, with an excellent bibliography, affords an opportunity for intensive study. The division of this section into radiation in general medicine and also in the various specialties make it particularly valuable as a

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note—Will secretaries of societies please co-operate with the Editor by supplying him with information for this section

CALIFORNIA

California Medical Association, Section on Radiology—*Chairman*, John D Lawson, M D, 1306 California State Bldg, Sacramento, *Secretary*, Karl M Bonoff, M D, 1930 Wilshire Blvd, Los Angeles Meets annually with California Medical Association.

Los Angeles County Medical Association Radiological Section—*President* John F Chapman, M D, 65 N Madison Ave, Pasadena, *Vice president*, E N Liljedahl, M D, 1241 Shatto St, *Secretary*, Merl L Pindell M D, 678 South Ferris Ave *Treasurer*, Henry Snure, M D, 1414 Hope Street Meets every second Wednesday of month at County Society Building

Pacific Roentgen Club—*Chairman*, Raymond G Taylor, M D, 1212 Shatto St Los Angeles, *Secretary*, L Henry Garland, M D, 450 Sutter St San Francisco

San Francisco Radiological Society—*Secretary*, L H Garland, M D, 450 Sutter Street Meets monthly on first Monday at 7 45 P M, alternately at Toland Hall and Lane Hall

COLORADO

Denver Radiological Club—*President* John S Bouslog M D, 246 Metropolitan Bldg, *Vice-president*, Sanford Withers M D, 304 Republic Bldg *Secretary*, Ernst A Schmidt M D, Colorado General Hospital, *Treasurer*, H P Brandenburg, M D 155 Metropolitan Bldg Meets third Tuesday of each month at homes of members

CONNECTICUT

Connecticut State Medical Society, Section on Radiology—*Chairman* Kenneth K Kinney, M D, 29 North Street Willimantic, *Vice chairman* Francis M Dunn M D 100 State Street New London, *Secretary-Treasurer* Max Climan M D, 242 Trumbull St Hartford Meetings twice annually in May and September

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society

FLORIDA

Florida State Radiological Society—*President*, Gerald Raap M D 168 S E First St Miami, *Vice president* H O Brown, M D, 404 First Nat'l Bank Bldg, Tampa, *Secretary Treasurer* H B McEuen, M D, 126 W Adams St Jacksonville

GEORGIA

Georgia Radiological Society—*President*, James J Clark, M D, Doctors Bldg, Atlanta, *Vice-president*, William F Lake, M D, Medical Arts Bldg, Atlanta *Secretary-Treasurer*, Robert C Pendergrass, M D, Prather Clinic, Americus Meetings twice annually in November and at the annual meeting of the Medical Association of Georgia in the spring

ILLINOIS

Chicago Roentgen Society—*President*, David S Beilin, M D, 411 Garfield Ave., *Vice-president*, Chester J Challenger, M D, 3117 Logan Blvd, *Secretary-Treasurer*, Roe J Maier, M D, 7752 Halsted St Meets second Thursday of each month, September to May, except December

Illinois Radiological Society—*President*, Cesare Gianturco, M D, 602 W University Ave, Urbana *Vice-president*, Fred H Decker, M D, 802-Peoria Life Bldg, Peoria, *Secretary-Treasurer*, Edmund P Halley M D, 968 Citizens Bldg, Decatur Meetings quarterly by announcement

Illinois State Medical Society, Section of Radiology—*President*, Roswell T Pettit, M D, 728 Columbus St, Ottawa, *Secretary*, Ralph G Willy, M D, 1138 N Leavitt St, Chicago

INDIANA

Indiana Roentgen Society—*President*, J N Collins M D, 23 E Ohio St, Indianapolis *President elect* Stanley Clark, M D, 108 N Main St, South Bend, *Vice-president*, Juan Rodriguez, M D, 2903 Fairfield Ave. Fort Wayne, *Secretary-Treasurer*, Clifford C Taylor, M D, 23 E Ohio St, Indianapolis Annual meeting in May

IOWA

The Iowa X-ray Club—Holds luncheon and business meeting during annual session of Iowa State Medical Society

MAINE

See New England Roentgen Ray Society

MARYLAND

Baltimore City Medical Society, Radiological Section—*Chairman* Marcus Ostro, M D, 1810 Eutaw Place *Secretary*, H E Wright, M D, 101 W Read St., Baltimore Meetings second Tuesday of each month

MASSACHUSETTS

See New England Roentgen Ray Society

MICHIGAN

Detroit X ray and Radium Society—*President* E W Hall, M D 10 Peterboro Street *Vice president*

with radium or radon causes the deterioration of albuminoid substances. First the molecule is altered, especially by amidogenic groupings. To this chemical alteration is added a physico-chemical phenomenon of colloidal flocculation which requires the presence of electrolites.

The sixth article, by Regaud and Hermet, deals with evolution of epitheliomas of the uterine cervix treated by radiotherapy and not cured. This report covers 873 cases treated between 1919 and 1928. Of this number, 28.7 per cent were cured and 71.2 per cent were not cured.

The seventh article, by Baclesse, bears on roentgen therapy for advanced epitheliomas of the uterine cervix and vagina. This article contains a report of nine cured cases out of 63, and discusses at some length the technical details of irradiation.

The eighth article, by Tailhefer, is a report of end-results of surgical treatment for metastatic lymphadenopathy secondary to cancer of the tongue.

The ninth paper, by Regaud, is a discussion of the treatment of epithelioma of the rectum and anus as practised at the Radium Institute.

PETIT GUIDE DE PHYSIOTHERAPIE (Small Guide of Physiotherapy) By VINCENT PASCHETTA, Electro-radiologiste des Hôpitaux de Nice, Chef du Service d'Electro-radiologie, et du Centre de Physiotherapie de l'Hôpital Saint-Roch. A volume of 190 pages. Published by L'Expansion Scientifique Française, 23, rue du Cherche-Midi, Paris, 1937. Price not given.

This is a small guidebook in physical therapy, stressing particularly deep roentgen-ray therapy. Chapters are devoted to the general principle of application and to the biologic properties of x-ray, radium, diathermy, the constant current, ultra-violet rays, and infra-red rays. The largest portion of the book is devoted to a dissertation on indications and technic for the use of the above-mentioned physical agents in the treatment of the following conditions: carcinomatous lesions, tuberculous lesions, inflammatory lesions, diseases of the nervous system, of the bones and joints, of the endocrine glands, of the skin, and of the digestive tract. Chapters are also included on nutritional maladies, and gynecological, urologic, otorhinolaryngologic, and circulatory diseases.

The author is most enthusiastic about deep x-ray therapy, which he recommends for many diseases. He has intentionally left out all references to other works in order to keep the book concise, as a sort of formulary on physical agents. It has been written specifically for general practitioners as a reference book. However, the reviewer questions whether it is sufficiently complete to serve this purpose fully. Some of the statements made by the author are not generally accepted in this country. For instance, the statement that "galvanization or galvano-irradiation is an excellent treatment for exophthalmic goiter and hyperthyroidism" might be questioned, as might be the statement that "diathermy is of value in treating diabetes." It can hardly be classified as a guidebook to physical therapy since it deals merely with a small phase of electrotherapy. Hydrotherapy and mechanotherapy are not discussed at all, and the description of the use of ultra-violet and infra-red rays is extremely limited. One gets the impression that the book is written by an x-ray therapist who has also some slight interest in a few other types of physical radiation. Deep roentgen-ray therapy seems to be over-stressed.

On the whole, this little book does, however, contain in a concise form a considerable amount of valuable information for the physician who may be interested in a few physical agents mentioned by the author.

THE PRACTICE OF IONIZATION By J. NEWTON DYSON, MRCS (Eng.), LRCP (London), with a Foreword by ELKIN P. CUMBERBATCH, M.A., B.M. (Oxon), D.R.M.E. (Camb.), FRCP. A volume of 178 pages, with 9 illustrations. Published by Henry Kimpton, London, 1936. Price \$1.50.

Cumberbatch in his introduction to this small monograph mentions the need for research in the field of electrotherapy. The volume itself, however, shows very little evidence of such scientific research. The first three chapters in this small book are devoted to the physics of electricity as applied to electrotherapy. The remainder of the book deals with "ionization" in the treatment of diseases. The author apparently uses the term "ionization" by choice rather than the more frequently accepted terms "iontophoresis" or "common ion transfer." Actually,

beth's Hospital Youngstown, *Secretary-Treasurer* Harry Hauser, M D, Cleveland City Hospital, Cleveland Meetings at 6 30 P M at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists)—*President*, George Benzmg, M D, St Elizabeth Hospital, Covington, Ky, *Secretary-Treasurer*, Justin E McCarthy, M D, 707 Race St, Cincinnati Ohio Meetings held third Tuesday of each month

PENNSYLVANIA

Pennsylvania Radiological Society—*President*, Sydney J Hawley, M D, Geisinger Memorial Hospital, Danville, *First Vice-president*, William J McGregor, M D, 744 Franklin Ave, Wilkensburg, *Second Vice-president*, Oscar M Weaver, M D, 12 S Main St, Lewistown, *Secretary-Treasurer*, Lloyd E Wurster, M D, 416 Pine St, Williamsport, *President-elect*, Charles S Caldwell, M D 520 S Aiken Ave, Pittsburgh Annual meeting May, 1938 Exact date and place to be decided

Philadelphia Roentgen Ray Society—*President* Thomas P Laughery, M D, Germantown Hospital, *Vice president*, Elwood E Downs, M D, Jeans Hospital, Fox Chase, *Secretary* Barton H Young, M D, Temple University Hospital, *Treasurer*, R Manges Smith, M D Jefferson Hospital Meetings first Thursday of each month from October to May, Thompson Hall College of Physicians 19 S 22nd St 8 15 P M

The Pittsburgh Roentgen Society—*President*, F L Schumacher, M D, Jenkins Arcade *Secretary*, H N Mawhinney, M D, Mercy Hospital Two Fall and two Spring meetings at time and place designated by president

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

South Carolina X-ray Society—*President* Robert B Taft M D 105 Rutledge Ave Charleston *Secretary-Treasurer* Hillyer Rudisill, M D Roper Hospital, Charleston Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association

SOUTH DAKOTA

Meets with Minnesota Radiological Society

TENNESSEE

Memphis Roentgen Club—Chairmanship rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

Tennessee State Radiological Society—*President*, H S Shoulders, M D 246 Doctors Bldg, Nashville, *Vice president*, S S Marchbanks, M D, 508 Medical Arts Bldg, Chattanooga, *Secretary-Treasurer*, Franklin B Bogart, M D, 311 Medical Arts Bldg, Chattanooga Meeting annually with State Medical Society in April

TEXAS

Texas Radiological Society—*President*, R G Giles, M D, Medical Arts Bldg, San Antonio, *President-elect*, Jerome H Smith, M D, Shannon West Texas Memorial Hospital, San Angelo, *First Vice-president*, C F Crain M D, 416 Chaparral St, Corpus Christi, *Second Vice-president*, M H Glover, M D, 904 8th St, Wichita Falls, *Secretary-Treasurer*, G D Carlson M D, 3121 Bryan St., Dallas Meets annually San Antonio is next place of meeting

VERMONT

See New England Roentgen Ray Society

VIRGINIA

Radiological Society of Virginia—*President*, Fred M Hodges, M D, 100 W Franklin St, Richmond, *Vice-president*, L F Magruder M D, Raleigh and College Aves, Norfolk, *Secretary* V W Archer, M D University of Virginia Hospital Charlottesville.

WASHINGTON

Washington State Radiological Society—*President*, H E Nichols M D Stimson Bldg, Seattle, *Secretary*, T T Dawson, M D, Fourth and Pike Bldg, Seattle Meetings fourth Monday of each month at College Club

WISCONSIN

Milwaukee Roentgen Ray Society—*Secretary*, S A Morton, M D, Columbia Hospital, Milwaukee Meets monthly on first Friday

Radiological Section of the Wisconsin State Medical Society—*Secretary* Russel F Wilson, M D, Beloit Municipal Hospital, Beloit Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September

University of Wisconsin Radiological Conference—*Secretary* E A Pohle, M D, 1300 University Ave, Madison Wis Meets every Thursday from 4 to 6 P M Room 301, Service Memorial Institute

offered in the first edition. Among the valuable features of this work are a chapter on methods of examination of the gall bladder and bile passages, including an excellent account of cholecystography by Lomon, and a section devoted to a detailed and excellent discussion of the semeiology of cholecystic disease. In the section devoted to diseases of the gall bladder a good deal of attention is paid to biliary stasis dependent on functional defects in evacuation. There are many American clinicians who may not agree with some of the theories advanced here, but the manner of presentation is, in general, critical and cautious. The chapter on medical treatment lays a great deal of stress on the advantages of duodenal drainage.

The work is almost encyclopedic in its completeness and gives every evidence of the great experience of the authors, who have been among the foremost French investigators in this field. There is an excellent bibliography at the end of each section containing practically all the literature on the subject subsequent to 1926. The work is perhaps somewhat too detailed for the general practitioner, but for those particularly interested in the diagnosis and treatment of cholecystic and biliary disease it may be recommended without qualification. The book is well illustrated and there are numerous colored plates.

ZEHN VORLESUNGEN UBER KYMOGRAPHIE (Ten Lectures on Kymography) By Dr med **PLEIKART STUMPF**, Associate Professor in the University of Munich. A volume of 112 pages, with 80 illustrations and a grid to demonstrate motion. Published by Georg Thieme, Leipzig, 1937. Price 8.70 RM.

This monograph contains ten lectures by the well-known pioneer in kymography and is intended to furnish the beginner with an introduction to the subject. The text is clearly written and covers sufficient ground to give an excellent foundation for further and more detailed studies. The illustrations are very instructive, showing the reader that by using a grid provided on a sheet of celluloid which can be moved across some of the reproduced kymograms, the careful observer—after a little practice—can obtain an effect very close to the actual appearance on the fluoroscopic screen. At the end of the book factors for the exposure technic with a 4-valve-tube-rectified machine are given. The author has also compiled data on the normal and pathologic picture of the heart, stomach, and genito-urinary tract, as well as the mechanism of respiration and swallowing. No bibliography is appended, but the reader is referred to the very complete review of the literature in the book published by the author in collaboration with Weber and Weltz in 1936. As an introduction to kymography this monograph is heartily recommended.

The next Annual Meeting of the Radiological Society of North America will be held at Pittsburgh, Pa., at the Hotel William Penn,

November 27–December 2, 1938

establish a high level of cancer therapy in a community. Seven years ago such a group was organized in the Baylor University Medical School. It is made up of fifteen well-trained men who work together in the outpatient department where only charity patients are used for study. Since practically no endowment is available, teaching, rather than the treatment of large numbers of patients, is considered to be the function of the clinic. Demonstrations are held each week before the senior students and all the physicians in the city are invited to attend and take an active part in the discussions. At intervals, joint presentations are made by members of the clinic staff before the hospital staff and before county medical societies. In the beginning many bitter arguments arose relative to methods of treatment, but the trial-and-error plan gradually eliminated these differences of opinion by vindicating those procedures which produced good results. At present the men who work in the clinic are prac-

tically agreed on plans of therapy and present a solid front when they participate in group programs. The formal exercises before students encourage study and accuracy, and the young men leaving the institution carry a knowledge of early diagnosis and proper treatment to other communities where its influence must eventually manifest itself. The slogan "consult your physician early" cannot mean very much to the layman until some such plan has become effective, particularly in the southern portions of the United States where accredited tumor clinics are widely scattered.

Pathology, surgery, and radiology form the triangle about which such clinics must be constructed, and the radiologist with his technical and clinical knowledge and experience in departmental organization is peculiarly fitted for leadership in work of this sort. Radiologists can do their bit for humanity in no better way than to energetically promote the tumor clinic plan so ably fostered by the American College of Surgeons.

CHARLES L. MARTIN, M D

COMMUNICATIONS

SECOND ANNUAL CLINICAL CONFERENCE OF MIDWESTERN RADIOLOGISTS

Kansas City, Mo., Feb 11-12, 1938

The Midwesterns Radiologists held an exceptionally good meeting, with an attendance of more than two hundred and fifty who gathered from fourteen States, Canada, and one foreign country. The banquet was preceded by a cocktail party, the evening being one of good fellowship and informality. The principal speaker at the dinner was Mr. Tom Collins of the *Kansas City Journal-Post*, whose subject was "Seeing is not Believing."

The program follows:

Clinical Significance of the Tuberculin Test
Herbert L. Mantz, M D, Director Tuberculosis Clinics, Health Dept., Kansas City, Mo.
Roentgenological Manifestation of Childhood Tuberculosis
E. R. Deweese, M D, F A C R, Radiologist, St. Mary's Hospital
Discussion—Hubert Parker, M D, Attending Physician, St. Mary's Hospital

Clinical, Roentgenological, and Pathological Findings in Secondary Lung Tumors

Charles E. Bell, M D, Asst. Radiologist, Research Hospital

Discussion—Frederick C. Narr, M D

Correlation of the Clinical and Roentgenographic Findings
Graham Asher, M D, Associate in Medicine, Univ. of Kansas School of Medicine

Clinical Differentiation of Coronary Disease and Upper Abdominal Pathology
Joseph E. Welker, M D, Asst. Prof. Medicine, Univ. of Kansas School of Medicine

Clinical Analysis of Sudden Death from Cardiac Disease
C. G. Leitch, M D, Pathologist, St. Mary's Hospital

Discussion—Galen Tice, M D, Radiologist, University of Kansas Hospitals

Evolution of Radiation Therapy for Carcinoma of the Cervix
E. H. Skinner, M D, F A C R, Consulting Radiologist, Kansas City General Hospitals

Discussion—David S. Dann, M D

Symposium on the Breast

Anatomy of the Breast
H. C. Tracy, M D, Prof. Anatomy, University of Kansas School of Medicine

The Roentgen Examination of the Breast
Ira H. Lockwood, M D, F A C R, Radiologist, Research Hospital

- FÜSSL, EMIL Contribution to the Roentgen Therapy of Metastatic Carcinoma of the Lungs
- GERLI, PIETRO Pulmonary Syphilis
- GLAUM KLAUS The Diagnosis of Cavity
- GOINARD, P., VIALLET, C., and MARCHIONI, R Traumatic Hematoma Encysted in the Splenic Region
- GÖKMEYER M with DESSAUER, F, jt auth
- GREBE L KROST, A., and PEUKERT, L Physical Experiments to Prove the Existence of Mitogenetic Radiation
- GUARINI, CARLO Radiography of the Coccyx
- Idem Roentgen Therapy in Subacute Inguinal Lymphogranulomatosis of Nicolas and Favre (The Fourth Venereal Disease)
- GÜTIG K Occurrence of a Sarcoma in the Scar of a Surgically Removed Roentgen Carcinoma
- HASCHÉ E, BOLZE, J v BOZÓKY, L., and v KEISER, D Contributions to the Dosage Measurement on Radium Packs
- HENSCHKE U, with FRIEDRICH, W, jt auth
- HENSSE H The Roentgen Investigation of the Operatively Delivered Kidney
- HEYERDAHL, S A Coutard Treatment of Malignant Tumors
- HOLFELDER H Classification of Roentgen and Radium Injuries in Relation to Indications for Roentgen and Radium Therapy
- Idem The Saturation Method in the Treatment of Malignant Disease, with Special Consideration of Holfelder's Modification
- HUPNAGL, H Ossification of the Achilles Tendon
- JAUSON, H The Advantages of Sensitization to Light in Treatment with Natural and Artificial Sources of Light
- JEUNE M, with SAVY, P jt auth
- KAHLSTORF, A The Expectancy of Life in Patients with Carcinoma of the Stomach
- KAUTZKY, A The Problem of Atypical Skin Reactions Following Roentgen Irradiation
- v KEISER, D with HASCHÉ E jt auth
- KILIAN HENRY A New Zone of Destruction in the Shoulder Blade in Rachitis
- KÖHLER A Medical Roentgenology around 1900
- KROST A, with GREBE L, jt auth
- KRUCHEN C Late Injuries Due to Roentgen Rays
- KUHLMANN B Prognosis of Roentgen Therapy in Actinomycosis of the Lungs
- LION K with DESSAUER F jt auth
- LÜDIN M Twenty Years of Roentgen Therapy
- McINTIRE, F T, and SMITH JEROME H X ray Therapy in the Treatment of Pneumonia
- MARCHIONI, R, with GOINARD, P, jt auth
- MEYER, S Physical Foundations of Emanation Therapy
- MONAUNI, J The Diagnosis of Butterfly like Shadows of the Lungs
- MOREAU with TOUPET jt. auth
- MÜLLER R Contribution to the Treatment of Hemangioma by Means of Radio-active Substances
- PAGANI, A Radiotherapeutic Experiences in the Treatment of Malignant Tumors of the Upper Air and Digestive Passages Complicated by Regional Lymph Gland Metastases
- PALMER I Ten Cases of Injuries to Crucial Ligaments in the Knee Joint Operated on and Reported
- PENDERGRASS E P, with FRAZIER C H jt auth
- PERSCHL, A The Roentgenological Diagnosis of Fractures of the Navicular Bone
- PEUKERT, L, with GREBE L, jt. auth
- PILCH D, with BRAUNBEHRENS H V, jt. auth
- POWELL, EUGENE V Roentgen Rays in the Diagnosis and Treatment of Pneumonia
- PRINZ, H Injuries of the Semilunar Cartilage
- RATHBONE, R RHETT Roentgen Therapy of Chronic Sinusitis in Children
- RAVICH, A, and TURKELTAUB, S M Solitary Cysts of the Kidney
- RUSS, SIDNEY The Indications for the Use of Radio-active Thermal Waters in Great Britain
- SAVY, P, FROMENT R, CHAPUY, A and JEUNE, M Anomalies of Pain in the Gastro-duodenal Ulcer
- SCHINZ, H R Fractional and Protracted Fractional Radiation Therapy
- SCHÜLE, H Surprising Response of Epidemic Meningitis to Roentgen Rays
- SCHULZE R, with FRIEDRICH, W, jt. auth
- SCHWALZ, G Development, Principles and Biological Foundations of Methods of Radiation Therapy
- SEINO, J Changes in the Pancreas Following Roentgen Irradiation
- SGALITZER, M Which of the Methods of Administering Roentgen Rays Is Most Suitable in the Treatment of Diseases of the Central Nervous System?
- SGALITZER, M, and UNGAR, E An Attempt to Carry Out Fitness Tests before Working with Roentgen Rays
- SMEBEKER H Dosimetric Problems in Radium and Roentgen Therapy
- SMITH, JEROME H, with McINTIRE F T, jt auth
- SPITZENBERGER O with FALTA, W jt auth
- STEPHENS, D J Chronic Myelogenous Leukemia Observations before and during Remissions Induced by Solution of Potassium Arsenite and by Roentgen Therapy with Particular Reference to Bone Marrow
- STÜHMER A The Method of "Three Fractional Doses in Roentgen Therapy of Skin Diseases"
- TALLA F Marconi therapy in Chronic Sinusitis
- TOUPET MOREAU DARIAUX, and CASSAN Cal cified Hydatid Cyst of the Liver
- TURKELTAUB, S M, with RAVICH, A jt auth
- UNGAR E with SGALITZER, M, jt. auth
- VANCE ROBERT G The Healing of Linear Fractures of the Skull
- VAN EVERDINGEN W A G Specific Action of Ultra short Waves
- VIALLET C with GOINARD, P, jt auth
- WALD BÉLA with BARSONY THEODOR jt auth
- WEBER E The Simple Fractional Dose Method in Radiation Therapy
- WEISS MIKLOS with BARSONY THEODOR jt auth
- WHITMORE EUGENE R The Nature of Certain Kidney Tumors
- WINDHOLZ F A Brief Discussion of the Histological Changes in Irradiated Blood Vessels
- WOLF P M with ZIMMER K G, jt auth
- ZIMMER K. G Measurements of Protection against Radiation
- ZIMMER, K G and WOLF P M Photographic Method for Testing Radium Applicators for Leakage
- ZWEIFEL C The Roentgen Diagnosis of the Patella

Ovarian Influence in Cancer Ferdinand C Helwig, M D, F A C P, Associate Prof Pathology, Univ of Kansas School of Medicine

Discussion—Lewis G Allen, M D

Neurogenic Factors in Functional Gastrointestinal Disturbances P T Bohan, M D,

F A C P, Prof Medicine, Univ of Kansas School of Medicine

Discussion—E R Deweese, M D

It's True but Who would have Thought of It? (3 15 to 5 P M) L G Allen, M D, David S Dann, M D, E R Deweese, M D, Ira H Lockwood, M D, L W Paul, M D, Galen Tice, M D, C Edgar Virden, M D

INTERNATIONAL RECOMMENDATIONS FOR X-RAY AND RADIUM PROTECTION

REVISED BY THE INTERNATIONAL X-RAY AND RADIUM PROTECTION COMMISSION AT THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY, CHICAGO, SEPTEMBER, 1937

INTERNATIONAL RECOMMENDATIONS

1 The dangers of over-exposure to x-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of x-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are

- (a) Injuries to the superficial tissues,
- (b) Changes in the blood and derangements of internal organs, particularly the generative organs

The evidence at present available appears to suggest that under satisfactory working conditions, a person in normal health can tolerate exposure to x-rays or radium gamma rays to an extent of about 0.2 international roentgen (r) per day, or 1 r per week. On the basis of continuous irradiation during a working day of seven hours, this figure corresponds to a tolerance dosage rate of 10^{-6} r per second. The protective values given in these recommendations are generally in harmony with this figure under average conditions.

I WORKING HOURS, ETC

2 The following working hours, etc., are recommended for whole-time x-ray and radium workers

- (a) Not more than seven working hours a day in temperate or cold climates. For workers in tropical climates, shorter hours may be desirable.
- (b) Not more than five working days a week, the off-days to be spent as much as possible out of doors.
- (c) Not less than four weeks' holiday a year, preferably consecutively.

- (d) Whole-time workers in hospital x-ray and radium departments should not be called upon for other hospital service.
- (e) X-ray, and particularly radium workers, should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general, and blood examinations, special attention being paid to the hands. These examinations will determine the acceptance, refusal, limitation, or termination of such occupation.
- (f) The amount of radiation received by operators should be systematically checked to ensure that the tolerance dose is not exceeded. For this purpose, photographic films or small-capacity condensers may be carried on the person.

II GENERAL X-RAY AND RADIUM RECOMMENDATIONS

3 X-ray departments should not be situated below ground-floor level.

4 All rooms, including dark rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

5 All rooms should be provided with adequate exhaust ventilation. In certain climates it may be necessary to have recourse to air conditioning. For rooms of normal dimensions, say 3,000 cubic feet (90 c meters) in which corona-free apparatus is installed, the ventilating system should be capable of renewing the air of the room not less than six times per hour, while up to ten times may be required when the apparatus is not corona-free. Large rooms require proportionately fewer changes

which showed a globular mass causing a disfigured and irregular appearance of the kidney. Treatment consisted in complete enucleation of the cyst. Nephrectomy was never necessary.

THE KNEE JOINT

The Roentgen Diagnosis of the Patella C Zweifel
Röntgenpraxis, May, 1937, 9, 313-318

Routine anteroposterior and lateral films of the patella often do not allow an adequate visualization. It may be difficult at times to determine the presence of a small fracture or other easily overlooked pathology. The author recommends a technic which was devised by Kuchendorf, but which has been forgotten by most radiologists. It allows the projection of four fifths of the patella in its anteroposterior aspect away from the condyles of the femur. The film is taken in postero-anterior direction, the knee is slightly flexed and rotated externally. The patella is subluxated in a lateral direction by manual pressure. The tube is angled from 15 to 20 degrees in a lateral direction. Five cases are reported in which this special technic allowed a much improved visualization of the patella and a more accurate diagnosis.

HANS W. HEFKE, M.D.

Ten Cases of Injuries to Crucial Ligaments in the Knee Joint Operated on and Reported I Palmer
Acta chir Scandinav, 1937, 79, 391-405 (Reprinted by permission from British Med Jour, Oct 30, 1937, p 65 of Epitome of Current Medical Literature)

Palmer considers that injuries to the crucial ligaments have become more common of recent years on account of the increased number of athletic and traffic accidents. It has been found that rotation and abduction or adduction trauma may give rise to injuries to the crucial ligaments in combination with other lesions. The diagnostic features are hyperextension, increased passive inward rotation, and the drawer sign, namely, ability to shift the tibia backwards and forwards on the femur with the knee flexed. X ray examination is often useful as an aid to diagnosis. Injuries of the crucial ligaments include overstretching, threadbareness total or partial rupture of the ligamentous substance, and rupture at the femoral or tibial attachment with or without the detachment of bony fragments. Early operative treatment is recommended as in cases of recent injury to the crucial ligaments direct suture may be possible. In later or chronic cases some plastic operation with tendons or fascia is necessary. In cases in which operation has been delayed subluxation may take place, with the development of a secondary arthritis deformans, which renders operative treatment impossible. In these cases an artificial jointed knee-cap helps the patient. The operative procedure is described, and ten cases are reported, in most of which recovery was complete after treatment by either suture or grafting.

Injuries of the Semilunar Cartilage H Prinz
Beitr z klin Chir, April 28 1937, 163, 337-375 (Reprinted by permission from British Med Jour, July 10, 1937, p 9 of Epitome of Current Medical Literature)

In the experience of the author these injuries more commonly affect the internal cartilage in the male sex and are to be diagnosed chiefly from signs of resistance to complete extension and from tenderness between the femur and the tibia when the leg is externally rotated on the thigh with the knee flexed. Each of these symptoms is occasionally absent in spite of a torn cartilage and each may sometimes be produced in the absence of a tear by the impaction of swollen synovial fringes or by a free foreign body. Steinhilber's sign (the shifting—backwards during flexion and forwards during extension of the knee—of the tender point) can sometimes be elicited. The presence or absence of effusion is not important in diagnosis, and a characteristic history is not always obtainable.

Ordinary roentgenography is seldom helpful, but in doubtful cases Böhm's method of roentgenography after intra-articular injection of from 3 to 4 c.c. of aqueous uroselectan B may be decisive. Endoscopy of the joint is more dangerous than surgical exploration and is unjustifiable. At Konjetzny's clinic, operation is preferred to conservative treatment for persistent or recurrent derangement. Although the injured and torn parts of the cartilage are removed, its capsular zone's capacity for regeneration is such that it may be left behind when possible unless the patient is engaged in heavy manual work.

Prinz discusses fully the etiology of the tearing of the semilunar cartilage. In all but three out of 15 cases microscopical examination showed chronic degenerative or inflammatory changes, which some German and Swiss writers have regarded as primarily causative trauma playing an unimportant part. Conclusions drawn from histological examination alone, however, are deceptive, it is certain that in a large majority of cases direct or indirect trauma is the chief etiologic factor.

LEUKEMIA

Chronic Myelogenous Leukemia Observations before and during Remissions Induced by Solution of Potassium Arsenite and by Roentgen Therapy with Particular Reference to Bone Marrow D J Stephens
Am Jour Med Sci, July 1937, 194, 25-34

The author points out that although the similarity of the therapeutic response of chronic myelogenous leukemia to roentgen therapy and to a solution of potassium arsenite is known, detailed studies of the bone marrow before and after treatment are not available. He reports observations in two patients, one treated with arsenic the other with roentgen therapy of the peripheral blood, bone marrow, oxygen consumption and nitrogen balance. In each instance treatment was followed by clinical improvement, reduction in total leukocytic count, especially the immature forms, improvement in anemia, return of oxygen consumption to a normal level and changes in the bone marrow.

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Discussion—Lewis G Allen, M D

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REVISED BY THE INTERNATIONAL X-RAY AND RADIUM PROTECTION COMMISSION AT THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY, CHICAGO, SEPTEMBER, 1937

INTERNATIONAL RECOMMENDATIONS

1 The dangers of over-exposure to x-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of x-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are

- (a) Injuries to the superficial tissues,
- (b) Changes in the blood and derangements of internal organs, particularly the generative organs

The evidence at present available appears to suggest that under satisfactory working conditions, a person in normal health can tolerate exposure to x-rays or radium gamma rays to an extent of about 0.2 international roentgen (r) per day, or 1 r per week. On the basis of continuous irradiation during a working day of seven hours, this figure corresponds to a tolerance dosage rate of 10^{-5} r per second. The protective values given in these recommendations are generally in harmony with this figure under average conditions.

I WORKING HOURS, ETC

2 The following working hours, etc., are recommended for whole-time x-ray and radium workers

- (a) Not more than seven working hours a day in temperate or cold climates. For workers in tropical climates, shorter hours may be desirable.
- (b) Not more than five working days a week, the off days to be spent as much as possible out of doors.
- (c) Not less than four weeks' holiday a year, preferably consecutively.

- (d) Whole-time workers in hospital x-ray and radium departments should not be called upon for other hospital service.
- (e) X-ray, and particularly radium workers, should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general, and blood examinations, special attention being paid to the hands. These examinations will determine the acceptance, refusal, limitation, or termination of such occupation.
- (f) The amount of radiation received by operators should be systematically checked to ensure that the tolerance dose is not exceeded. For this purpose, photographic films or small-capacity condensers may be carried on the person.

II GENERAL X-RAY AND RADIUM RECOMMENDATIONS

3 X-ray departments should not be situated below ground-floor level.

4 All rooms, including dark rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

5 All rooms should be provided with adequate exhaust ventilation. In certain climates it may be necessary to have recourse to air conditioning. For rooms of normal dimensions, say 3,000 cubic feet (90 c meters) in which corona-free apparatus is installed, the ventilating system should be capable of renewing the air of the room not less than six times per hour, while up to ten times may be required when the apparatus is not corona-free. Large rooms require proportionately fewer changes

series was repeated in four weeks with good improvement. Three and a half months afterward the chest was practically negative. Two years later after numerous colds in the interim, the disease recurred and now showed a new focus of about apple-size in the right hilum. Treatment was given again but in spite of it the condition of the patient grew worse and apparently he developed an involvement of the upper thoracic spine. This area was also treated and in January, 1936, he was completely free from symptoms and has remained so until July, 1937. The author emphasizes that apparently early roentgen therapy, combined with potassium iodide and gold medication, is very effective in the treatment of actinomycosis.

ERNST A. POHLE, M.D., Ph.D.

Roentgenological Observations in a Honey-comb Lung. H. V. Braunbehrens and D. Pilch. *Röntgen praxis*, May, 1937, 9, 297-304.

The diagnosis of honey-comb lung or congenital cystic disease of the lungs has been made much more frequently during the last few years than before the general use of roentgen rays. Ring shadows, sometimes with a fluid level, are seen in lung areas which usually are emphysematous. This system of cavities or cysts is usually in direct connection with the bronchial tree. The mediastinum may be displaced, occasionally a pneumothorax is present. Bronchography may be used for confirmation in doubtful cases.

The case reported by the authors showed all the classical signs in the roentgen films. They were limited to the right, middle, and lower lobes. A bronchography showed multiple cavities; it proved that one dealt with a so-called open cystic lung.

Tomographic examination seemed to indicate an absence or poor development of the blood vessels in the diseased area. The kymogram showed a marked inspiratory shift of the mediastinum toward the right, indicating that the right lung was practically useless as far as vital capacity was concerned. The pneumothorax, found at the first examination, was apparently one of the causes of the dyspnea, which improved after the pneumothorax became smaller.

HANS W. HEFKE, M.D.

The Diagnosis of "Butterfly like" Shadows of the Lungs. J. Monau. *Röntgenpraxis*, January, 1938, 10, 1-4.

This contribution to the differential diagnosis of butterfly like lung shadows tries to explain its anatomical and pathological basis. The term is meant to indicate a bilateral hilar wing-like infiltration.

In the case reported by the author this appearance was due to a tuberculosis which was disseminated mostly in the region of the upper interlobar spaces in both lungs. The differential diagnosis between the different types of tuberculosis and Boeck's sarcoid is discussed. The question is raised if lung infiltration of the described type may not be distributed in or

around the interlobar spaces in other diseases of the lungs also. Special roentgenologic studies for instance Fleischner's position, should be able to prove or disprove such localization of lung lesions.

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LYMPHOGRANULOMA

A Case of Diabetes Insipidus Due to Lymphogranuloma. W. Falta and O. Spitzenberger. *Strahlentherapie*, 1937, 60, 385.

The authors report a case of Hodgkin's disease with multiple glandular involvement and a mediastinal mass. After some initial response to roentgen therapy, the patient developed diabetes insipidus. Roentgenograms of the skull showed decalcification of the posterior clinoid process. Assuming a lymphogranulomatous focus in the hypophysis, the gland was subjected to radiation but without striking response. Autopsy verified the diagnosis.

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Roentgen Therapy in Subacute Inguinal Lymphogranulomatosis of Nicolas and Favre (The Fourth Venereal Disease). Carlo Guarini. *Arch. di Radiol.* 1937, 8, 32-36.

Guarini has treated eleven cases of this lesion between 1922 and 1936 and obtained good results in eight of them. He uses the following technique: 180 kv, 3 ma, 40 cm T.S.D., 0.5 mm zinc + 2 mm aluminum, a field about 10 × 15 cm (to include the lesion). He gives from 200 to 300 r per treatment every four or five days and uses from four to twelve treatments according to the clinical indications. He thinks that x-ray treatment should be more commonly used in the treatment of this disease.

E. T. LEDDY, M.D.

MENINGITIS, EPIDEMIC

Surprising Response of Epidemic Meningitis to Roentgen Rays. H. Schüle. *Strahlentherapie* 1937, 60, 318.

Several years ago roentgen therapy was recommended for cases of tuberculous meningitis, but controls on a large material did not prove it to be effective. Little is known, however, regarding the response of epidemic meningitis to radiation therapy. The author reports such a case of a 20-year-old male who was treated over the left temporal area with 165 r (180 kv, 0.5 mm Cu). Within 24 hours there was a striking improvement in the condition of the patient so that no further treatment was given. Recovery followed and about five weeks after the treatment the patient could be discharged. Although this is only a single observation, the author feels encouraged by his experience to give this method a trial.

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radiation Protective screens and applicators (cones) used in treatment to define the ports of entry of γ -ray beams should be sufficiently thick to reduce the dosage rate outside the direct field of irradiation to less than 10^{-3} roentgen per second

IV ELECTRICAL PRECAUTIONS IN X-RAY ROOMS

23 The floor-covering of the γ -ray rooms should be insulating material such as wood, rubber, or linoleum

24 Where permanent overhead conductors are employed, they should be not less than 9 feet (3 meters) from the floor They should consist of stout metal tubing or other coronaless type of conductor The associated connecting leads should be of coronaless wire kept taut by suitable rheophores

25 Wherever possible, earthed guards or earthed sheaths should be provided to shield the more adjacent parts of the high tension system Unshielded leads to the γ -ray tube should be in positions as remote as possible from the operator and the patient. The use of "shock-proof" γ -ray equipment, in which the high tension circuit is completely enclosed in earthed conductors, is recommended In all cases, however, indiscriminate handling of γ -ray tubes during operation should be forbidden Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed

26 Main and supply switches should be very accessible and distinctly indicated They should not be in the proximity of the high tension system, nor should it be possible for them to close accidentally The use of quick-acting, double-pole circuit breakers is recommended Over-powered fuses should not be used If more than one apparatus is operated from a common generator, suitable high tension, multi-way switches should be provided In the case of some of the constant potential generators, a residual charge is held by the condensers after shutting down, and a suitable discharging device should, therefore, be fitted Illuminated warning devices which operate when the equipment is "alive" serve a useful purpose The staff should be trained in the use of first-aid instructions dealing with electrical shock If foot switches are used they should be connected in series with an ordinary switch, and should be so designed that they cannot be locked to keep the circuit

"alive," and are not capable of being closed accidentally

27 Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the γ -ray tube

28 Low flash-point anesthetics should never be used in conjunction with γ -rays

V FILM STORAGE PRECAUTIONS

29 The use of non-inflammable γ -ray films is strongly recommended In the case of inflammable films, suitable precautions should be taken as regards their use and storage Large stocks should be kept in isolated stores, preferably in a separate building or on the roof

VI RADIUM PROTECTIVE RECOMMENDATIONS

(A) *Radium Salts*—30 Protection for radium workers is required from the effects of

(a) Beta rays upon the hands,

(b) Gamma rays upon the internal organs, vascular and reproductive systems

31 In order to protect the hands from beta rays, reliance should be placed, in the first place, on distance The radium should be manipulated with long-handled forceps, and should be carried from place to place in long-handled boxes, lined on all sides with at least one centimeter of lead All manipulations should be carried out as rapidly as possible

32 Radium, when not in use, should be stored in a safe as distant as possible from the personnel It is recommended that the safe should be provided with a number of separate drawers individually protected The amount of protection should correspond to the values given in the following table These values, which are based on working conditions where there is proximity to radium, may be reduced for larger working distances

Maximum Quantity of Radium Element	Thickness of Lead
0.05 gm	5 cm
0.2	8.5
0.5	10
1.0	11.5
2.0	13
5.0	15
10.0	17

33 A separate room should be provided for the "make-up" of screened tubes and applicators, and this room should be occupied only during such work

34 In order to protect the body from the penetrating gamma rays during handling of

series was repeated in four weeks with good improvement. Three and a half months afterward the chest was practically negative. Two years later, after numerous colds in the interim the disease recurred and now showed a new focus of about apple size in the right hilum. Treatment was given again but in spite of it the condition of the patient grew worse and apparently he developed an involvement of the upper thoracic spine. This area was also treated and in January, 1936, he was completely free from symptoms and has remained so until July 1937. The author emphasizes that apparently early roentgen therapy, combined with potassium iodide and gold medication, is very effective in the treatment of actinomycosis.

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The distances corresponding to the tolerance dosage rate in the absence of lead are also given

Members of Committee Making Above Report

DR G W C KAYE,
(Great Britain) *Hon. Secretary*
DR H BEHNKEN, Germany
PROF E PUGNO-VANONI, Italy
DR I SOLOMON, France
MR LAURISTON S TAYLOR, U S A

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

EINFÜHRUNG IN DIE KURZWELLENTHERAPIE (Introduction to Short Wave Therapy) Second Edition. Behandlungstechnik und Indikationen (Technic of Management and Indications) By ERNST FRITSCH and MARTIN SCHUBART. A volume of 200 pages, with 117 illustrations. Published by Urban & Schwarzenberg, Berlin, 1938. Price RM 5.50.

RADIUM LOST AND FOUND. By ROBERT B. TAFT, M.D., B.S., M.A., F.A.C.R. A monograph of 76 pages. Published by John J. Furlong and Son, Charleston, S.C., 1938. Price \$2.00.

THE ORIGIN AND PROPERTIES OF THE HUMAN AURA. By OSCAR BAGNALL, B.A. (Cantab). A volume of 192 pages. Published by E. P. Dutton & Company, Inc., New York City, 1938. Price \$2.00.

THIRD SYMPOSIUM ON SILICOSIS. An official transcript of the Third Silicosis Symposium held in connection with the Trudeau School of Tuberculosis at Saranac Lake, N.Y., June 21 to 25, 1937. A volume of 265 pages. Edited by B. E. Kuechle, Vice President and Claims Manager, Employers Mutual Liability Insurance Company, Wausau, Wisconsin, 1937. Price \$3.00.

X-RAYS AND RADIUM IN THE TREATMENT OF DISEASES OF THE SKIN. By GEORGE M. MACKEE, M.D., Professor of Clinical Dermatology and Director of Department of Dermatology (Skin and Cancer Unit), New York Postgraduate Medical School and Hospital, Columbia University. Consulting Dermatologist, St. Luke's Hospital. Third Edition, thoroughly revised. A volume of 330 pages, illustrated, with 308 engravings, 31 charts, and 2 colored plates. Published by Lea & Febiger, Philadelphia, 1938. Price \$10.00.

BOOK REVIEWS

RÖNTGENDIAGNOSTIK DER KNOCHEN- UND GELLENKCRANKHEITEN (Roentgen Diagnosis of Bone and Joint Diseases) Vol. II, Knochenechinokokkose (Echinococcus Disease of Bone). By PROF. ROBERT KIENBÖCK, Vienna. A volume of 192 pages, with 19 illustrations. Published by Urban & Schwarzenberg, Berlin, 1933. Price RM 7.60.

In this monograph the author has summarized the main facts known to medicine regarding the infections of bone by the *Echinococcus*. After a brief discussion of the etiology of the disease, noting that there are two forms, cystic or hydatid, and the infiltrating or granulomatous form, he reviews the clinical course of the disease. He then enumerates the cases reported, with the bones involved, and summarizes these facts in the form of a table. In all, there are 86 such cases. A review of five cases seen in his own clinic is given and this is followed by a chapter on differential diagnosis.

As a reference book on this interesting but rare disease this monograph is well worth while. It is fairly well illustrated and so arranged as to be most handy as a reference book.

STUDIEN ÜBER HEREDITÄRE MULTIPLE EPIPHYSENSTÖRUNGEN (Studies of Hereditary Multiple Epiphyseal Affections). By S. RIBBING. Acta Radiologica Supplementum XXXIV. A volume of 107 pages, with 94 illustrations. Published by Mercator Tryckeri, Helsingfors, Finland, 1937. Price Swedish cr 8.00.

In this monograph the author has described a peculiar type of hereditary multiple epiphyseal disturbances studied by him. The series includes 23 cases, all related. The lesions were not uniform throughout but were all epiphyseal, resembling in some instances achondroplasia and similar generalized types and in other instances osteochondritis dissecans, coxa plana, dorsal juvenile kyphosis, *et cetera*. A complete review of the literature is given.

The significance of the condition is not known but its relationship to the type of epiphyseal disturbance mentioned above offers much interesting food for thought. The patients did not have any obvious constitutional disturbance or other anomalies. These cases are illustrative of the doctrine of the "constitutionally weak epiphysis."

trauma in the orbital region, and some indistinct visual disturbances. This examination was mostly useful in cases of unilateral lesions.

G E BURCH, M D

THE PANCREAS

Changes in the Pancreas Following Roentgen Irradiation J Seino *Strahlentherapie*, 1937, 58, 449

The author studied the relation between the condition of the islands of Langerhans and the sugar metabolism. In order to produce hypertrophy of the islands he used ligation of the pancreatic ducts, partial removal of the glands, roentgen irradiation and chronic starvation of the rabbits. The assimilation of sugar is not as much disturbed following irradiation as after partial extirpation of the gland or ligation. However, there was definite histologic evidence of injury of the pancreatic tissue. No hypertrophy or hyperplasia of the islands was seen in the irradiated part of the pancreas. No stimulative effect of roentgen rays could be detected. In animals with hypoglycemia the islands were not hypertrophied or hyperplastic but the sugar metabolism was disturbed. The author concludes from his experiments that the pancreas of the rabbit can definitely be injured by roentgen irradiation.

ERNST A. POHLE, M D, Ph D

PEPTIC ULCER

Anomalies of Pain in the Gastro-duodenal Ulcer P Savy, R Froment, A Chapuy and M Jeune *Presse med*, April 21, 1937, 45, 609-610 (Reprinted by permission from *British Medical Jour*, July 10, 1937, p 5 of *Epitome of Current Medical Literature*)

The authors describe the common signs and symptoms of gastro-duodenal ulcer, including pain in the epigastrium with dorsal or thoracic radiation which appears some time after meals and is relieved by the ingestion of food. Pain usually lasts for about three weeks with intervals of remission for several months. As a result of observation in 215 cases of peptic ulcer certain anomalies have been noted. In some cases the pain may be felt in an unusual region such as the dorso-lumbar and instances are given in which a duodenal ulcer caused pain of the pseudo-nephritic type or pain in the left lumbar area. Hypogastric and pseudo-intestinal types were also seen in the first of which the pain started in the left iliac fossa and in the second in the appendicular region. In other instances the pain originated in the thoracic region before extending to the abdomen.

It was noticed that in certain cases pain was not relieved by eating, and on occasion it occurred soon or immediately after taking food. Anomalies regarding the duration of the attacks were also observed: two cases are quoted in which they lasted only three days, and another in which a period of quiescence lasting for 18 months was followed by pain several times a day with an interval of only one or two days between.

Other anomalies which may lead to a mistaken diag-

nosis include raised temperature, vomiting, and pain simulating that of cholecystitis. In those cases which do not present the typical symptoms of peptic ulcer roentgenography is necessary in order that a correct diagnosis may be made.

PHYSICAL THERAPY

Specific Action of Ultra short Waves W A G van Everdingen *Acta Radiologica*, August, 1937, 18, 543-546

The rise of temperature of the irradiated body depends upon many factors, some of which cannot be determined in the living tissue. The specific resistance of the object, the mass of the object, the dielectric constant, the heat conductivity, and the emissivity of the body are important ones. The cooling effect of the blood in the living animal is an integrating factor.

The author looks upon the problem from two different angles. First, the action of ultra short waves may be explained upon the principle founded on the change of the dielectricum when living tissue is brought into the condenser-field of a high frequency circuit, and second, he considers the importance that may be attached to the dipole theory of Debye.

G E BURCH, M D

PNEUMONIA

Roentgen Rays in the Diagnosis and Treatment of Pneumonia Eugene V Powell *Texas St Jour Med* October, 1937 33, 427-431

The author has for four and one half years employed x ray therapy in 103 cases of lobar pneumonia with a mortality under 5 per cent. The only contra-indication is a definite leukopenia such as is seen in post-influenzal pneumonias.

The technic consists of from 250 to 350 roentgens of 0.3 Ångström unit effective radiation given over the involved portion of the lung repeated over an opposite skin area in 48 hours if the temperature does not return to normal.

JOHN M. MILLS, M D

X ray Therapy in the Treatment of Pneumonia F T McIntire and Jerome H Smith *Texas St Jour Med* October 1937 33, 422-426

The authors review 38 cases of pneumonia which they treated with x ray with a corrected mortality of 13.7 per cent for the cases of bronchopneumonia and 9.1 per cent for the cases of lobar pneumonia. Dosage employed was 110 r measured with back scatter using 140 kilovolts through a 20 cm portal and repeating this dose in forty-eight hours if necessary.

They believe x ray therapy is of value in all types of pneumonia exhibiting an adequate white blood count except in very early cases of bronchopneumonia with considerable congestion or a minimum consolidation.

JOHN M. MILLS, M D

steady reference volume for both those of wide experience and those of lesser experience

FRACTURES AND DISLOCATIONS FOR PRACTITIONERS By EDWIN O. GECKELER, M. D., Fellow of the American College of Surgeons, Fellow of the American Academy of Orthopedic Surgeons. A volume of 246 pages, with 213 illustrations. Published by William Wood & Company, Baltimore, 1937. Price \$4.00

The author states in the preface that his purpose is "to condense the subject of fractures and dislocations without the omission of important details." This purpose has been well carried out and there are ready references for those wishing detailed information. The subject is condensed into 246 pages of easily readable type and is sufficiently illustrated with 213 drawings, x-ray reproductions, and photographs. Special attention is given to preparation and application of plaster of Paris.

The subject matter is introduced by a discourse on general considerations, including general directions for guidance of x-ray work in fractures through the courtesy of Dr. Roscoe C. Webb, Chief Surgeon of the Great Northern Railway Company. This speaks for the attempt to cover completely the necessities of fracture work. The author has commendably stressed the taking of early x-rays for diagnosis and the use of frequent check-up x-rays.

Criticism may be offered in the fact that, as the book is primarily for the practitioner, there is not enough attention directed toward the complications which frequently arise, such as Volkmann's ischemic contracture, early care of traumatized soft tissue and compound wounds. However, the book should be a handy reference work for the practitioner because of its clear, concise, and condensed presentation of fractures and dislocations.

RADIOPHYSIOLOGIE ET RADIOTHERAPIE (Radiophysiology and Radiotherapy) *Recueil de Travaux Biologiques, Techniques et Therapeutiques* (Review of Biologic Work, Technique, and Therapeutics). A periodical published from time to time, of which this is the number for March, 1937, Vol. III, fasc. 3, by the Institut du Radium of the University of Paris and the Curie Foundation. A volume of 470 pages. Price 50 fr.

In this number are a series of articles by the

different workers at the Radium Institute of Paris. The first article, by Ferroux, Regaud, and Samssownow, deals with the increase in radioresistance of seminal epithelium by the use of small doses of roentgen rays. The result of this experimental study showed that a dose of 750 roentgens, divided into ten equal fractions and given at monthly intervals over a period of ten months, diminished the radio-sensitiveness of the seminal epithelium.

The second article, by Lacassagne, is a report of studies on the physiologic modifications in the ovary of adult rabbits after partial or complete destruction of the hypophysis by radon, together with the changes occurring in the hypophysis after irradiation with roentgen rays as compared with those occurring after irradiation by radon introduced into the gland. Lacassagne concludes that it is possible to destroy the hypophysis of the rabbit by introducing radon into the gland. Such destruction provokes in the ovary important and histologically characteristic alterations. Preservation of about a third of the anterior lobe of the hypophysis insures the maintenance of normal genital function, in spite of the disappearance of the remainder of the hypophysis and of the intermediate and posterior lobes. Histologic examination of incompletely destroyed hypophyses proved that the hypophyseal cells are only slightly radiosensitive. Irradiation of the hypophysis with roentgen rays confirms the resistance of this organ to irradiation.

The third article, also by Lacassagne, is a report of experiments on the radiosensitiveness of the corpus luteum and of the uterine mucosa of the rabbit by means of an artificial desiduoma. These experiments showed that strong irradiation of the ovary before the rupture of the follicles does not prevent the formation of corpora lutea which retrogress prematurely, and this is accompanied by the disappearance of cellular proliferation in the uterine mucosa. Moderate irradiation does not prevent the normal development of corpora lutea. The uterine mucosa proliferates and, in cases of unilateral irradiation, artificial desiduomas are formed on the treated side as well as on the untreated side.

The fourth article, by Ferroux and Folichon, deals with the leakage of radon from radium tubes, especially from the strong tubes employed for teleradium therapy.

The fifth article, by Loiseleur, is a report of investigations which show that irradiation

his own technique. As an example he quotes that in a patient who receives six or eight fields the daily dose per area is from 300 to 330 r (in air). In the case of six fields, two areas are given each day for a period of three days and beginning the fourth day one field is given daily. After three weeks one field is given every other day. He believes that this method uses fully the selective effect of radiation as based on the difference in cumulation in normal and diseased tissue.

ERNST A. POHLE, M.D., Ph.D.

An Attempt to Use Provocation of the Radiosensitive Phases of Cell Life as an Adjunct to Fractional Radiation Therapy. T. Berkman and F. Dessauer. *Strahlentherapie* 1937, 58, 551.

It is known that heat shortens the time period of cell division. Since during mitosis cells are most susceptible to irradiation the author used diathermy in patients with inoperable malignancies before radiation therapy in an attempt to sensitize the tumor cells. The interval between heat application and irradiation was usually one hour. While only 12 cases have been studied so far and in some patients no benefit of the diathermy application could be seen, a few showed rather striking responses. The authors believe it to be worth while therefore to continue these experiments.

ERNST A. POHLE, M.D., Ph.D.

Fractional and Protracted Fractional Radiation Therapy. H. R. Schinz. *Strahlentherapie* 1937, 58, 541.

The author uses at his clinic the following four types of application of roentgen rays: simple fractionation with short treatment periods, protracted fractional irradiation with short treatment periods, fractional irradiation with long treatment periods, and protracted fractional irradiation with long treatment periods. His daily doses vary from 14 to 40 r/min for the short treatment periods and 2.5 r/min for the long treatment periods. His results obtained by the original Coutard method in the treatment of carcinoma of the upper respiratory tract and esophagus are published in the same journal (Vol. 58, p. 373). In conclusion the author emphasizes that in his opinion an improvement of the results obtained by radiation therapy in cancer can be obtained only by earlier diagnosis.

ERNST A. POHLE, M.D., Ph.D.

Physical Experiments to Prove the Existence of Mitogenetic Radiation. L. Grebe, A. Krost, and L. Peukert. *Strahlentherapie* 1937, 60, 575.

The existence of mitogenetic radiation discovered by Gurwitsch is accepted by some and denied by other investigators. The authors studied the problem with a modified Geiger counter using the roots and leaves of plants and also frog hearts as test objects. They

came to the conclusion that there are mitogenetic rays probably in the region of from 1,800 to 2,700 Å.

ERNST A. POHLE, M.D., Ph.D.

RADIATION INJURIES

Late Injuries Due to Roentgen Rays. C. Kruchen. *Strahlentherapie*, 1937, 60, 486.

The author reports two cases of late injuries occurring years after the exposure to roentgen rays. The first patient, now 65 years old, was treated over the thyroid twenty years ago. Atrophy of the skin with telangiectasis developed several years after the irradiation. A few months ago the patient noticed difficulty in swallowing and clinical examination revealed a carcinoma of the hypopharynx which was proved by biopsy. What connection this malignancy has to the previous irradiation is difficult to say, although the changes in the skin may lead one to suspect certain injuries in the deeper structures. A second patient was operated on several times for sarcoma in the right groin. Fairly heavy doses of x-rays were applied for the treatment of a recurrence. Two years following the last treatment there developed an ulcer 12 × 9 cm large and 4 to 5 cm deep. In this case the disturbance of the blood supply and lymphatic drainage may explain the increased sensitivity to radiation.

ERNST A. POHLE, M.D., Ph.D.

A Brief Discussion of the Histological Changes in Irradiated Blood Vessels. F. Windholz. *Strahlentherapie*, 1937, 59, 662.

The author reports the results of his studies carried out in serial sections of a roentgen ulcer in the abdominal wall of a patient who had received over that area a single dose of 1,500 r filtered through 4 mm Al. His histologic studies showed that the veins were much more affected than the arteries. The findings are discussed in detail and illustrated by five photomicrograms. An additional illustration shows the identical microscopic picture in the perichondrium taken from the larynx of a patient who had been treated with the Coutard method and received 5,340 r within 35 days. He died from pneumonia 75 days after the last treatment. It is concluded that the observed changes in the veins are in all probability due to a direct effect of the radiation on the vessel walls.

ERNST A. POHLE, M.D., Ph.D.

Classification of Roentgen and Radium Injuries in Relation to Indications for Roentgen and Radium Therapy. H. Höffelder. *Strahlentherapie* 1937, 60, 66.

Following a brief discussion of the medico-legal aspect of roentgen and radium injuries the author proposes a classification of these lesions which in his opinion would greatly facilitate their evaluation in forensic medicine. The following groups are given: (1) pigmentation of skin, (2) telangiectasis, (3) atrophy.

he describes the procedure commonly called "galvanization" and maintains that the polarity of the constant low voltage current is of little importance

Many claims are made for the value of "ionization" in the treatment of diseases of the joints, muscles, and nerves, as well as diseases of the nose and ear. Rather exaggerated claims are made for the value of "ionization" in the treatment of atrophic arthritis and other ankylosing joint diseases. The author bases these claims on what he terms the "sclerolytic" action of the current. As a result of the "sclerolytic" action, rather startling results are claimed in the treatment of otosclerosis. It is contended that in many instances hearing is restored.

The work is not convincing since there are only a few case reports, no statistical studies, no controlled studies, and there is no experimental material. Likewise, there is no bibliography. Not even a theoretical presentation of the physiologic action of the constant current is presented to substantiate the many positive statements which have been made. It would seem that all of the work presented in this book should be much more thoroughly substantiated before the views of the author are given general acceptance.

ELEMENTS OF CHROMOTHERAPY, THE ADMINISTRATION OF ULTRA-VIOLET, INFRA-RED, AND LUMINOUS RAYS THROUGH COLOR FILTERS. By R. DOUGLAS HOWAT, L.R.C.P. (Edin.), L.R.C.S. (Edin.), L.R.F.P.S. (Glas.), with a Foreword by SIR HENRY GAUVAIN, M.D., M.Chir., F.R.C.S. A volume of 106 pages, with 20 illustrations. Published by The Actinic Press, Ltd., London, 1938. Price 8/6d.

This small monograph, as the title suggests, describes the use of visible and invisible light rays through colored filters. There are chapters on history, physics, erythema, action on bacteria, filters, lamps, technic, and clinical observations.

The work discusses chiefly the use of visible light through colored filters and makes many extravagant claims for the value of such radiations. Since no less an authority than W. W. Coblentz, of the Washington Bureau of Standards and member of the Council on Physical Therapy of the American Medical

Association, has stated, "If the rays in the visible spectrum have any special therapeutic action, it remains to be determined," and since practically all modern experts in light therapy have considered that the use of colored lights can have no other effect than a psychic one, this text was reviewed carefully to see whether there was any new material in it which would warrant the claim by Doctor Howat that "chromotherapy was of value."

When one reads his chapter on the action of color rays on bacteria, at first glance, he seems to present a rather imposing array of direct quotations from other writers to support his views. On more careful check-up with the brief bibliography that he has appended at the end of the book, it was found that a number of his sources of reference were not given and that those which were given were extremely antiquated. For instance, in this chapter, the references given were dated, respectively, 1877, 1904, 1858, 1883, 1879, 1889, and 1903. Such antiquated material, all of it over twenty-five years of age, of course merits no consideration in a modern textbook. A check of the bibliography shows that of the forty-five references for which dates are given, twenty-one are over twenty-five years old. The author bases his contentions on such obsolete material and on twenty-five sketchy case reports of a highly unscientific nature. Typical of these case reports is the first one describing treatment of "acidity" by application of a "red filter over epigastrium for fifteen minutes." It is reported that after a dozen treatments, the patient "was absolutely free from symptoms and declared that she had never felt so fit." Need more be said concerning this volume?

The Reviewer is rather amazed that a medical man could write such an unscientific text, and that one so famed as Sir Henry Gauvain should be willing to lend his name to its publication. This text cannot be recommended.

LA VÉSICULE BILIAIRE ET SES VOIES D'EXCRETION (The Gall Bladder and Biliary Ducts) By M. CHIRAY, J. PAVEL, and A. LOMON. A volume of 863 pages. Second Edition. Published by Masson et Cie, Paris, 1936. Price 120 fr.

The second edition of this standard work enlarges and brings up to date the material

studied (See "Strahlentherapie," 1932, 43, 667) The authors suggest the use of water as absorbing material instead of wood, and also refer the dose to 1 mg of radium element The equivalent for this "normal cube minute" was determined at 0.00412 r

ERNST A. POHLE, M.D., Ph.D.

Radium Therapy of Cancer of the Oral Cavity H. E. Davis Illinois Med Jour October, 1937, 72, 320-323

Davis considers the use of low intensities of radium over a period of days to be effective in the treatment of carcinoma Six to ten skin erythema doses were found to be most effective for the complete destruction of most squamous-cell carcinomas With the exception of a few locations, such as the alveolar ridge, interstitial radiation was the method of choice for the treatment of oral cancer Radium needles of low intensity, 0.5 to 1.0 mg per linear cm., were ordinarily employed They were screened with 0.5 mm of platinum, thus allowing the use of only the pure gamma rays The needles were spaced accurately about 10 to 12 mm apart throughout the involved area The period of application varied from 4 to 12 days continuously, depending upon the location, extent, and probable histology of the primary tumor In certain locations radon implants were found practical, the dosage tables by Dr. Martin, Mrs. Quimby and Dr. Pack being used
G. E. BURCH, M.D.

Further Experience with Injections of Radium Chloride W. Altschul Strahlentherapie 1937 60, 381

The author reports on his experience with injection of radium chloride during the last five years He saw good results in ischias, arthritis of the shoulder and knee, rheumatism, and neuritis Certain types of arteriosclerotic disturbances as, for instance, intermittent claudication, were also improved The injections are given in two series of six each, 3×1 mc and 3×2 mc on six successive days There were no untoward reactions

ERNST A. POHLE, M.D., Ph.D.

The Indications for the Use of Radio-active Thermal Waters in Great Britain Sidney Russ Proc Royal Soc Med, May, 1937 30, 831-832

In a discussion of spa waters Professor Russ points out that the radium or radon in spa waters has often been put forward as a reason for some of the therapeutic value of the drinking water of the spa He also points out that if this were so spa waters richest in these elements would be among the most noted This, however, is not the case The drinking water of Stockholm is more radio active than the water from any of Sweden's spas Since radon water can be prepared cheaply if the curative value of spa waters were due to this element the value of such resorts would disappear rapidly

In reply to the statement that small quantities of radium invigorate the body Professor Russ has cal-

culated that such water could safely supply only one-millionth of the heat requirements of the body Similar calculation of the oxidation properties of clinically tolerated doses gives a very small figure.

Finally, the author points out the work of Howitt in administering radon impregnated water These results indicated that in the systematic treatment of cases of rheumatism and allied affections, no demonstrable change was found in the clinical condition, including a two-year follow-up

The great benefit patients derive from spas is apparently not due to radio-activity but no doubt to the medical advice received, the regime of life followed, and the other chemical compounds contained in such waters

W. A. SODEMAN, M.D.

Photographic Method for Testing Radium Applicators for Leakage K. G. Zimmer and P. M. Wolf Strahlentherapie 1937 58, 174

The regulations for radiation protection in Germany demand that all radium applicators be tested every three months for leakage The authors describe their experiments, showing that the photographic method if carried out with certain precautions is suitable for this purpose

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Contributions to the Dosage Measurement on Radium Packs E. Hasché, J. Bolze, L. v. Bozóky and D. v. Keiser Strahlentherapie, 1937, 60, 598

The authors describe in detail the results of their photographic determinations of radium doses with the photographic method developed by Holthausen and his co-workers (see this Journal 1932 43, 667) They found that gamma rays of radium and roentgen rays excited at 470 kv (H.V.L. 4.6 mm) produce about the same degree of blackening of an x-ray film with a dose of 0.72 r The accuracy is ± 20 per cent

ERNST A. POHLE, M.D., Ph.D.

The Problem of Radium Dosimetry Fundamental Principles of the Ionization Method W. Friedrich, R. Schulze and U. Henschke Strahlentherapie 1937 60, 38

The authors continued their experimental investigations dealing with the determination of radium doses in r They found that this is possible with air wall chambers They found equal ionization currents if the electron emission of air under 150 atmospheres pressure was compared with that of graphite Equal ionization currents were also obtained when comparing chambers made of tissue paper and air wall chambers, provided that the room was sufficiently large ($100 \times 50 \times 22$ meters) and the radium was at a distance of 20 meters from the chamber The authors conclude that accurate results can be obtained only if air wall chambers of sufficient wall thickness are used and if scattered gamma radiation is avoided The equivalent for 1 mg hr was found to be 7.8 r

ERNST A. POHLE, M.D., Ph.D.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Hernia	523	Radiation	529
Keloids	523	Radiation Injuries	530
The Kidneys	523	Radiation Therapy	531
The Knee Joint	524	Radiology, Practice of	531
Leukemia	524	Radium	531
The Liver	525	Rickets	533
Light Therapy	525	Roentgenology, History of	533
The Lungs	525	Roentgen-ray Therapy	533
Lymphogranuloma	526	Roentgen Sickness	533
Meningitis, Epidemic	526	The Sinuses	534
Metaplasia	527	Skin Diseases	534
Nervous System	527	The Skull	535
Orbital Region	527	The Spine	535
The Pancreas	528	The Spleen	535
Peptic Ulcer	528	The Stomach	535
Physical Therapy	528	Syphilis	535
Pneumonia	528	The Trachea	535
Pneumoperitoneum	529	Tumors (Therapy)	535
Protection	529	The Wrist	536

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S M ATKINS M D of Waterbury, Conn	L G JACOBS M D, of Madison, Wis
S RICHARD BEATTY, M D, of Madison, Wis	E T LEDDY, M D, of Rochester, Minn
G E BURCH M D of New Orleans, La	JOHN M MILES, M D, of Houston, Tex
J E HABBE, M D, of Milwaukee, Wis	E A POHLE, M D, Ph D, of Madison Wis
HANS W HEFKE M D, of Milwaukee, Wis	J C RODICK, M D, of New Orleans, La
W A SODEMAN, M D of New Orleans La	

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

ALEXANDER FAY K The Roentgen Diagnosis of Intra abdominal Hernia	523	CHAMBERLIN, GEORGE W, with FRAZIER, C H, jt auth	535
ALPERS BERNARD J, with FRAZIER, C H jt. auth	535	CHAOU, H A Definition of the Technical Factors in Roentgen Therapy with Small Focal Skin Distances and its Differentiation from Other Similar Methods	533
ALTSCHUL, W Further Experience with Injections of Radium Chloride	532	CHAPUY A with SAVY P, jt auth	528
ARNETH, J Qualitative and Quantitative Changes in Thrombocytes in Chronic Myelogenous Leukemia under the Influence of Roentgen Rays	525	COOPER S B Carcinoma Tongue—Radium Treatment and its Technic	533
AUBRY and BERTRAND-GUY Artificial Pneumoperitoneum	529	DARIAUX with TOUPET jt auth	525
BAENSCH, W Radiation Therapy of Keloids	523	DAVIS H E Radium Therapy of Cancer of the Oral Cavity	532
BARGI, LUIGI The Anatomic Value of the Sharp Interlobar Projection of the Lung	525	DESSAUER, F, with BERKMAN, T, jt auth	530
BÁRSONY, THEODOR, and WALD BÉLA The Normal Trachea in Anteroposterior Roentgenograms	535	DESSAUER F, LION, K, and GÖKMEN, M Experiments with the Rotation Method in Roentgen Therapy	531
BÁRSONY, THEODOR, and WEISS, MIKLOS The Analysis of Increased Densities over the Nasal Sinuses Due to Projection	534	ELLINGER, F Cell Permeability and Effect of Irradiation	529
BELLER, A Lupus Sarcoma	534	FALTA W, and SPITZENBERGER, O A Case of Diabetes Insipidus Due to Lymphogranuloma	526
BERKMAN, T and DESSAUER F An Attempt to Use Provocation of the Radiosensitive Phases of Cell Life as an Adjunct to Fractional Radiation Therapy	530	FARBEROV, B J Roentgenological Diagnostics of the Foramen Opticum	527
BERTRAND-GUY, with AUBRY, jt auth	529	FORFOTA E The Systemic Effect of Roentgen Rays with Special Consideration of a Shocking Effect Produced by Histamine or Histamine like Substances	533
BOLZE, J with HASCHÉ E, jt auth	532	FOX, EVERETT C Treatment of Skin Cancer	534
BORAK J Late Results of the Fractional Protracted Dose Method	529	FRAZIER, C H, ALPERS, BERNARD J, PENDERGRASS E P, and CHAMBERLIN, GEORGE W The Effects of Irradiation on Gliomas	535
v BOZÓKY L, with HASCHÉ E, jt auth	532	FRIEDRICH, W, HENSCHKE U, and SCHULZE, R The Problem of Radium Dosimetry The Photographic Method	531
BRAGG W H Roentgen Rays and Gross Structure of Matter	531	FRIEDRICH, W, SCHULZE R, and HEVSCHKE U The Problem of Radium Dosimetry Fundamental Principles of the Ionization Method	522
BRAUVDREHNS, H V and PILCH D Roentgenological Observations in a Honey-comb Lung	526		

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ERNST A. POHLE, M.D., Ph.D.

HERNIA

The Roentgen Diagnosis of Intra abdominal Hernia
Fay K Alexander *Am Jour Roentgenol and Rad Ther*, July 1937, 38, 92-101

Intra abdominal hernia which term is preferred to such terminology as duodenal, paraduodenal descending mesocolon, ascending colon hernia etc, is probably present more frequently than is supposed. The diagnosis, which can be made solely by roentgen examination, requires a longer study of the small bowel than is commonly made, for the meal must be followed through at least the proximal half of the jejunum to see the abnormal course, the close approximation and apparent binding together of the loops as if held in a sac. In the five patients reported, the distal duodenum and duodeno-jejunal junction ran an abnormal course. Post operative adhesions and congenital short mesentery may produce similar findings. Abdominal pain exaggerated by exertion erect posture, or eating and relieved by retching or recumbent posture, or smaller meals, or food with but slight roughage should bring this condition to mind. The etiology appears to be congenital rather than acquired.

S M ATKINS, M D

KELOIDS

Radiation Therapy of Keloids W Baensch *Strahlentherapie*, 1937, 60, 204

The author relates his technic of treating keloids. He uses radium needles of 1, 2, and 4 cm length containing 1, 2, and 4 mg, respectively. They are filtered through 0.5 Pt. Sometimes the insertion of these needles is combined with surface applications at 1 cm distance and according to the size of the lesion 80-800 mg-hr are given. Before developing the radium technic roentgen rays were administered in doses of 300-500 r filtered through 4 mm Al. A review of 58 treated cases showed that 36 were subjected to radium therapy, thirteen showed excellent response, eleven were considerably improved, six improved and six did not respond. Twenty-two keloids were treated by roentgen rays, eight of these showed excellent results, four were considerably improved, three improved, and seven did not respond. The author concludes that the combined radium implantation and surface application is the most promising method.

ERNST A POHLER M D, Ph D

THE KIDNEYS

The Nature of Certain Kidney Tumors Eugene R Whitmore *Southern Med Jour* December 1937, 30, 1149-1157

Cases illustrative of epithelial and connective tissue tumors of the kidney are presented. One of these tumors microscopically hypernephroid, has metastases some of which are hypernephroid and some sarcomatous with no adrenal cortical hormone in either the primary tumor or its metastases.

The author's explanation for the dual nature of the

metastases is that the cells of the kidney developing from mesoderm, retain their potentialities to form both epithelium and connective tissue, one potentiality being dominant, the other recessive. In neoplasia both potentialities may be exercised, so metastases may be partly hypernephroid and partly sarcomatous.

With this explanation it is not necessary to assume misplaced cortical cells as the origin of a primary epithelial tumor or 'sarcomatous degeneration' of the stroma to account for sarcoma metastases from such a tumor.

JOHN M MILES, M D

The Roentgen Investigation of the Operatively Delivered Kidney H Hensser *Schweiz med Wchnschr*, July 10, 1937, 67, 630-632

The author feels that the standard methods of investigating the kidney in cases of stone are not entirely satisfactory, and that the taking of films on the operatively delivered kidney will give more information. Not only can the number and size, but also the position, type, and build be determined. He describes the technic in some detail. The waterproof sterilizable bags used are closed with zippers. The method can also be used to obtain pyelograms at the time of operation, either intravenous or retrograde filling of the pelvis, or filling by direct puncture, being employed. The method is stated to be easy of application.

L G JACOBS, M D

Solitary Cysts of the Kidney A Ravich and S M Turkeltaub *Urol and Cutan Rev*, April, 1937, 41, 260-264 (Reprinted by permission from *British Med Jour* June 26 1937 p 102 of *Epitome of Current Medical Literature*.)

The authors report seven cases in patients aged from 41 to 69 of whom four were men and three women. In five instances there were definite associated pathological lesions which may have contributed to the formation of the renal cysts. In three cases nephrolithiasis with moderate infection was present and in one case an infiltrating papillary carcinoma of the ureter with secondary hydronephrosis was found. The fifth patient had chronic nephritis with hypertension, arteriosclerosis and diabetes, and another case had a renal calculus on the opposite side. The present series therefore, supports Hepler's view that any lesion, local or constitutional, capable of causing tubular occlusion and interference with blood supply, may be responsible for the formation of these cysts. The lesion in the present cases varied in size from that of a small tangerine orange to that of a large sac containing over 1,500 cc of fluid. In all the cases the lower pole of the kidney was involved. In six cases the anterior and in two the posterior surface were the sites of origin. All the cases were histologically benign. Five of the cysts contained straw-colored fluid and two hemorrhagic fluid. No special symptoms were encountered, and most of the patients sought advice for an associated lesion. Diagnosis was made by x-ray examination.

THE SINUSES

The Analysis of Increased Densities over the Nasal Sinuses Due to Projection Theodor Bársony and Miklos Weiss *Röntgenpraxis*, January, 1938, 10, 5-8

A slight deviation from the correct positioning of the head for the different postero anterior positions used for the demonstration of the nasal sinuses may produce a definite but false density over the maxillary and ethmoid sinuses. Correct positioning may be judged accurately on the film by noting the position of the dental process of the second cervical vertebra. Any deviation of the dental process from the midline is always responsible for definite changes in the density of the antrum. The side toward which the dens is deviated is cloudy. Quite often the ethmoidal cells appear to be falsely cloudy at the side opposite the deviation of the dental process.

HANS W. HEFKE, M.D.

Roentgen Therapy of Chronic Sinusitis in Children R. Rhett Rathbone *Am Jour Roentgenol and Rad Ther*, July 1937, 38, 102-108

In 70 children with sinus disease followed from one to three and one half years by roentgen examinations before and after roentgen treatment 57 per cent were cured, 28 per cent improved and 15 per cent were not benefited.

The ideal type for roentgen therapy is the one with diffuse lymphoid hyperplasia throughout the nose and throat, hyperplasia of the mucous membrane of the antra, ethmoids and adenoids the last of which can be shown in the lateral view which always should be taken in children. The roentgen prescription employed was either 125 kv (peak) 5 ma 12-inch distance, 5 mm Al filter, and a dose of 120 r or 220 kv (peak) 20 ma, 50 cm distance 0.5 mm copper filter and a dose of 100 r (measured in air). The treatments were given three times per week for two weeks through portals of 10 x 10 cm or 7 x 7 cm, through anterior and right and left fields in rotation and only one field per day. In seven cases with recurrent sinus disease the series was repeated in six months to one year with excellent results in four.

The diagnosis of this disease is not easy and is frequently marked by cough lung congestion bronchiectasis, asthma otitis media mastoiditis, and cervical adenopathy which may be either associated with this disease, or the result of it.

S. M. ATKINS, M.D.

Marconi therapy in Chronic Sinusitis F. Talia *Arch di Radiol* 1937, 8, 23-31

Talia reports favorable results in a group of cases of sinusitis after the use of short wave therapy.

E. T. LEDDY, M.D.

SKIN DISEASES

Treatment of Skin Cancer Everett C. Fox *Southwestern Med*, October, 1937, 21, 354-357

The author lists the precancerous dermatoses and the different types of skin malignancy outlining the treatment which he considers offers the best prognosis.

JOHN M. MILES, M.D.

The Method of 'Three Fractional Doses' in Roentgen Therapy of Skin Diseases A. Stuhmer *Strahlentherapie*, 1937, 60, 706

The author discusses the method of application in dermatological roentgen therapy. For many years it has been the custom to apply about 20 per cent of the skin erythema dose every ten days. Based on the investigations of Miescher, who found a definite rhythm in the skin reaction following exposure to roentgen rays, the author suggests trying the following method: 30 per cent of the erythema dose is given first, 20 per cent after ten days, 10 per cent ten days later. If more treatment is required, 10 per cent may be given on the fortieth and on the fiftieth day. The chosen periods correspond to the three erythema cycles described by Miescher.

ERNEST A. POHLE, M.D., Ph.D.

Lupus Sarcoma A. Beller *Strahlentherapie*, 1937, 60, 210

The author reports a case of a man 72 years of age who had been treated for lupus of the skin. In one of the scars a nodule developed and grew within eight weeks to 2 cm diameter. Excision by the endotherm knife was done, biopsy showed a polymorph cell sarcoma. The wound healed within six weeks at that time a recurrence of bean size developed. Roentgen therapy was given to that area (185 kv, 0.5 mm Cu, 60 per cent H.E.D.). The growth responded promptly and the patient has been free from recurrence for one year and three months.

ERNEST A. POHLE, M.D., Ph.D.

The Problem of Atypical Skin Reactions Following Roentgen Irradiation A. Kautzky *Strahlentherapie*, 1937, 60, 439

It is known that exposure to roentgen rays may provoke skin eruptions in patients with hyperthyroidism, psoriasis, and syphilis. The author has observed a number of cases belonging to this group and describes for instance the appearance of an acne rosacea in some of the irradiated areas in a woman who received roentgen deep therapy over the pelvis for carcinoma of the cervix. Another patient treated for hyperthyroidism developed urticaria not only in the treated fields but in various other parts of the body. A patient with hemolytic icterus developed a marked erythema in the skin.

In both patients the gray hyperplastic marrow was replaced by a hypocellular fibrotic marrow. Roentgen therapy was followed by a marked increase in the nitrogen excretion, potassium arsenite was not

W A SODEMAN M D

Qualitative and Quantitative Changes in Thrombocytes in Chronic Myelogenous Leukemia under the Influence of Roentgen Rays J Arneth *Strahlentherapie* 1937 59 104

The author studied the behavior of the blood platelets in myelogenous leukemia before, during, and after roentgen therapy. He found that the blood platelets may be increased but are also occasionally found decreased. During roentgen therapy in patients with myelogenous leukemia they are subject to great variations, a marked drop may well be a contra indication to further radiation therapy. He discusses at length the relation between the changes in the blood platelets and the left and right shift in the leukocytes. Great reduction in the number of the platelets during treatment may be followed by hemorrhagic diathesis and lead to death. The variations in the platelets cannot be explained by a direct effect of roentgen rays on these cells.

ERNST A POHLE, M D Ph D

THE LIVER

Calcified Hydatid Cyst of the Liver Toupet, Moreau Dariaux and Cassan *Bull et Mém Soc Radiol Méd de France* February, 1937, 25, 115-117

A hydatid cyst with calcification of the wall was demonstrated roentgenologically to arise from the liver. The diagnosis was confirmed by operation.

S RICHARD BEATTY, M D

LIGHT THERAPY

The Advantages of Sensitization to Light in Treatment with Natural and Artificial Sources of Light H Jauson *Strahlentherapie*, 1937 60, 82

The author relates his experience with sensitizing substances administered orally, rectally, and intravenously. He used methylene blue, eosin, and Hofmann's violet. Especially in countries with a low percentage of sunny days this procedure should be of value.

ERNST A POHLE M D Ph D

THE LUNGS

The Diagnosis of Cavity Klaus Glaum *München med Wchschr*, Sept 24 1937 84, 1539-1541

The author believes that in diagnosing cavity a correlation between clinical and roentgen findings is

essential. He illustrates this view with a well-chosen case report showing how neglect of the clinical aspects may lead one astray.

L G JACOBS, M D

Contribution to the Roentgen Therapy of Metastatic Carcinoma of the Lungs Emil Füssli *Röntgenpraxis*, March, 1937, 9, 184-190

Persistent and well planned series of roentgen treatments are able to achieve marked subjective improvement in some cases of metastatic cancer of the lungs. It may even be possible to expect a cure in rare cases. It is the author's opinion that treatment should not be stopped after the metastases have regressed, but that it should be continued until the extreme limits of tolerance have been reached.

A case of cancer of the thyroid is reported which showed lung metastases eight years after surgical removal of the primary tumor. The lungs were treated by massive doses (2,400 r to each of four fields). Five such series were given and after their completion a definite regression and almost complete disappearance of the large metastatic nodules were noted on roentgenograms of the chest. Three more similar series were administered during the next two years. In the course of four years, 20,000 roentgens were given to the lungs. The patient died from metastases to the brain. The autopsy showed comparatively little involvement of the lungs.

HANS W HEFKE M D

The Anatomic Value of the Sharp Interlobar Projection of the Lung Luigi Bargi *Arch di Radiologia*, 1937 15, 177-197

The author discusses the diagnostic importance of the capillary interlobar lines and illustrates it by reproductions of roentgenograms. He shows how they may be missed by the incorrect angle of incidence and the changes they undergo when taken at the correct projection. The line is of importance in the diagnosis of interlobar pleurisy.

E T LEDDY M D

Prognosis of Roentgen Therapy in Actinomycosis of the Lungs B Kuhlmann *Strahlentherapie*, 1937, 60, 476

The author reports a case of a man 50 years of age who developed a cough in 1931, with a good deal of expectoration and sharp pain in the right chest. Examination of the sputum was negative for tuberculosis. A roentgenogram of the chest showed a diffuse radiopacity in the middle part of the upper right chest extending into the mediastinum. Re-examination of the sputum finally showed actinomycoses. (The patient reported that he had dressed a deer and noticed a tumor on the jaw in all probability this constituted the source of infection.) In September 1931 he received x ray therapy over the upper right chest. On four successive days 200 r were given over each area. The

numerous portals and up to the limit of skin tolerance per field, better results can be anticipated

S M ATKINS M D

Coutard Treatment of Malignant Tumors S A Heyerdahl Acta Radiologica, May, 1937, 18, 399-412

The author relates experiences with the Coutard treatment during 1932 and 1933 with follow up for from two and one half to four years. Sixteen out of 25 cases of carcinoma of the throat and other air passages were symptom free. Of nine patients with bone tumors all were free of pain after Coutard treatment, and four of them symptom free after from two and one half to four years. The author states that if attention is concentrated not solely on the permanent results, but also on the immediate effects of the treatment the method must be said to be very promising and of importance to the patient. The mode of treatment and complications observed are also given.

W A SODEMAN, M D

Radiotherapeutic Experiences in the Treatment of Malignant Tumors of the Upper Air and Digestive Passages Complicated by Regional Lymph Gland Metastases A Pagani Strahlentherapie 1937, 60, 675

In this third part of his report, the author discusses tumors of the epipharynx, hypopharynx and larynx. Twenty six patients with tumors of the epipharynx with metastatic glands showed a three-year survival of 25 per cent and a five year survival of 20 per cent. Protracted fractional roentgen therapy is the method of choice. Small local residual tumors are removed with the endotherm knife or are treated by radium implantation. Any residual lymph glands are removed surgically, provided of course that the primary lesion has been completely eradicated. Treated by the same method were 151 patients with tumors of the hypopharynx with metastatic glands. After three years 13 per cent survived and after five years 7 per cent. Thirty four cases with carcinoma of the larynx were

seen, only six of these had metastatic glands. One of the cases with metastases in the glands was alive at the end of five years. The author emphasizes again the relationship between prognosis and metastases in the regional glands.

ERNST A POHLE M D, Ph D

THE WRIST

The Roentgenological Diagnosis of Fractures of the Navicular Bone A Perschl Röntgenpraxis, January, 1938, 10, 11-16

Fractures of the navicular bone of the wrist are not uncommon. The statistical material of the Clinic of Boehler, in Vienna, shows that there is found one recent fracture of the navicular bone to five of the wrist itself. Its definite diagnosis is often impossible by clinical examination and assured only by x ray examination. If not diagnosed and not immobilized for at least six weeks a long lasting disability and pseudoarthrosis may follow. The standard positions for roentgen examination of the wrist are the lateral and dorso-palmar views. The author shows that these two exposures are not sufficient in many cases of fractures of the navicular bone. Four positions are at present used routinely in Boehler's Clinic: the two standard views and two special positions for better visualization of the small bones of the wrist, especially the navicular. For one of them the direction of the central ray is dorso-palmar, but the fingers are flexed to almost make a fist, for the second position the fingers are flexed and the hand is supinated to an angle of 45 degrees.

By means of several case reports and reproductions of films the author proves his contention that in some cases fractures of the navicular bone cannot be diagnosed without the two special views. Of 302 recent fractures of that bone seen during the last eleven years at Boehler's Clinic, all healed with bony union when diagnosed correctly and treated by immobilization for a sufficient time—at least six weeks.

HANS W HEFKE M D

METAPLASIA

Ossification of the Achilles Tendon H Hufnagl
München med Wehnschr, Sept 3, 1937, 84, 1410

The author classifies tendinous ossifications into three groups first, ossification in ligamentous attachments, second, those in tendinous attachments of muscles, and third, those within the tendon itself. The first two groups are easily explained by periosteal overgrowth or by traumatic tearing with ossification. The third is less easily explained, previous writings differing in their explanation. Metaplasia, or ossification in a connective tissue altered by inflammatory changes, will summarize them. A case report supports the metaplastic theory. The patient developed this ossification after repeated trauma and microscopic examination of the excised specimen showed increase of intra tendinous connective tissue with hyaline swelling, atrophy of the tendon fibers punctate calcification of the connective tissue, and metaplasia into cartilage and bone. A review of another such case (of Höring) fits in with this opinion.

L G JACOBS, M D

NERVOUS SYSTEM

Which of the Methods of Administering Roentgen Rays is Most Suitable in the Treatment of Diseases of the Central Nervous System? M Sgalitzer Strahlen-therapie, 1937 58, 571

The author considers the fractional dose method as most suitable in the treatment of diseases of the central nervous system by roentgen rays. He recommends using four to five fields whenever possible and starting the series with a test dose of 50 r. If there are no severe reactions the dose may be increased up to 150 r per area. Medium high total doses seem advisable and the best results have been obtained in his experience when operation was combined with post-operative x-ray therapy.

ERNST A POHLE M D, Ph D

ORBITAL REGION

Roentgenological Diagnostics of the Foramen Opticum B J Farberov Acta Radiologica August 1937 18 594-606

Farberov studied the variations in the normal and abnormal optic foramen, he described the technique he employed and found to be satisfactory. From a study of over 400 patients, most of which had ocular complaints, the author found no differences in the optic foramen which could be attributed to sex or race. Minimum diameters of 2.8 mm and maximum diameters of 6.0 to 6.5 mm were considered to be the normal range. When the two diameters did not differ by more than one third and the patient was symptom free the author did not consider the findings abnormal. Thinning of the contour of the foramen was not always pathological. After four to five years of age the optic foramen does not change in size or shape. Tumors of the optic nerve produced large (three to four times the normal size) and thin optic channels. Small tumors

may produce very little change. Unilateral or bilateral constriction of the foramen was found in five patients (one with syphilis, one with Crouzon's disease, and the etiology remained unknown for the others). Osteoplastic metastasis from a distant primary focus may, in rare cases, produce constriction of the channel-diameter. Examination of the foramen opticum is profitable in studying the growth of osteomas of the orbital wall or air cavities. The author in analyzing his data grouped the alterations found in the foramen opticum, the adjoining orbital districts and in the paranasal sinuses as follows:

- (A) *Alterations of the form of foramen opticum due to*
 - (1) congenital deformation,
 - (2) acquired deformation
- (B) *Alterations of the dimensions of the foramen opticum*
 - (1) enlargement of the channel lumen (a proportional one with retention of the original form, and a non-proportional one without alteration of the original form)
 - (2) decrease of the dimensions (a circular and non-proportional flattening of one diameter)
- (C) *Alteration of the outline of the foramen opticum*
 - (1) thinning,
 - (2) partial or general thickening
 - (3) breaking up of the continuity of the outline,
 - (4) sulcus in the floor for the arteria ophthalmica
- (D) *Complete destruction of the foramen opticum*
- (E) *Alterations inside the channel lumen—horizontal calcification strip separating the lower smaller part of foramen opticum for arteria ophthalmica* (In our material we discovered in one instance also a vertical calcification strip inside the channel lumen, no patho histological examination followed. This case represented optic nerve atrophy.)
- (F) *Alterations of the small wing of the osseus sphenoidalis*
 - (1) general thickening and condensation of the whole wing,
 - (2) air cavities inside the processus clinoides anterior
- (G) *Alterations of the sinus sphenoidalis and of the posterior cells of the sinus ethmoidalis of the same side* (also in Highmore cavity and the sinus frontalis)
 - (1) diffuse shading of the cavities,
 - (2) sclerosed cavities,
 - (3) distinctly confined shadows of tumors of rhinogenic origin
- (H) *Alterations of the external orbital wall*
 - (1) thickening, hyperostosis,
 - (2) slit shaped and channel shaped defects,
 - (3) breaks in the bone integrity (fissures, fractures)

All of these enumerated alterations were observed in various combinations. In approximately one third of all cases examination of the foramen opticum was helpful for the discernment and the minute definition of the character and the spreading of the various diseases of the orbital region. The examination was particularly serviceable in cases of retrobulbar neuritis, choked disks, optic nerve atrophy, exophthalmos.

wave length to be obtained with the voltage in question. Or the electron may penetrate the space lattice of the target to some depth with a gradual loss of energy, and then collide head-on with a nucleus, with the consequent production of a light quantum of smaller energy and hence longer λ -ray wave length. Or the moving electron may eject an electron from one of the inner shells of some atom, creating a vacancy there which, when filled by an electron dropping into it from an outer shell, will give rise to one of the λ -ray spectrum lines characteristic of that particular shell in that particular kind of atom.

We have so far followed the electron from its original position in the cathode across the vacuous space of the tube and into the space lattice of the target. But it must either get back through the external circuit to its starting point in the cathode or some other electron must be caused to take its place there. For the mechanism of electron flow through the metallic conductor, we must look to the physicist specializing in this field in which rapid strides have been made during the past few years.

Leaving now the electron and coming to the λ -rays resulting from its more or less rapid deceleration we have seen that, owing to the structure of the target, the λ -ray beam of necessity is heterogeneous, covering a wide range of wave lengths. By filtration the percentage of the longer wave lengths can be reduced.

As the λ -rays pass through matter (the patient, for example), they produce within this matter photoelectrons and Compton recoil electrons. These, in turn, eject other electrons of lower velocity, and it is this last ionizing process to which we must look for physiological effects and for mensuration. A photoelectron is ejected with almost the full energy of the λ -ray quantum while a Compton recoil electron receives only a small fraction of this, the balance going into a quantum of scattered λ -radiation.

We see then that even our superficial discussion of what is involved in the

mechanism of λ -ray production, mensuration, and utilization has involved thermionics, electron optics, the indeterminacy principle, relativity, quantum mechanics, the crystal space lattice, the structure of the atom with its nucleus and with its extra-nuclear electrons arranged in definite energy levels, electrical conduction in the solid state, the Compton effect, etc., in short, a large fraction of our modern physics.

We come now to the development of λ -ray generating apparatus. Many of the early radiologists were able technicians and took an active part in the development of what now would be regarded as a feeble source of radiation. With the substitution later by Snook of the transformer and mechanical rectifier for the induction coil and revolving plate static machine which had first been used, the adequacy and dependability of the high voltage power supply were increased to a point where the λ -ray tube itself became the limiting factor.

The early hot-cathode high-vacuum λ -ray tube shifted the burden to the high voltage generator, as this tube was capable of operating at the full voltage obtainable from the λ -ray transformers in use at the time of its advent.

Following the demands of the medical profession, larger rectifiers and transformers, good for 200,000 volts, were built and, in turn, tubes to take all that these generators could deliver.

The urge for still higher voltages came both from the medical profession, for therapy, and from industry, for the radiography of thick metal sections.

So far as the tube was concerned, it had been shown that the most troublesome factor in going to much higher voltages lay in the production of field currents when the potential gradient at the surface of the cathode became too high. It had also been shown that this difficulty could be obviated by the use of multi-section tubes containing a plurality of electrodes each of which was maintained at the proper potential.

PNEUMOPERITONEUM

Artificial Pneumoperitoneum Aubry and Bertrand-Guy Bull et Mém Soc Radiol Méd de France, February, 1937, 25, 130-133

Artificial pneumoperitoneum is a useful diagnostic procedure which makes possible the detection of pathology not demonstrable by ordinary roentgenograms. It has been, in the authors' experience, innocuous. It is especially available in cases that have had ascites. Three cases are presented demonstrating its value in the diagnosis of intraperitoneal adhesions.

S RICHARD BEATTY, M D

PROTECTION

An Attempt to Carry Out Fitness Tests before Working with Roentgen Rays M Sgalitzer and E Ungar Strahlentherapie, 1937, 58, 701

The authors discuss a problem of great interest to the radiologist, namely, the testing of persons who intend to enter an occupation which exposes them to x-rays or radium. They studied first the behavior of normal adults to a general body exposure given at 1.3 meter distance with 170 kv, 0.5 mm Cu + 1 mm Al, and a dose of 15 r over the anterior and posterior aspects. After certain normal figures have been established as to the reactions of the leukocytes, they propose to use these as the basis of a test. Anyone whose leukocytes show a higher susceptibility to roentgen rays should be advised accordingly.

ERNST A POHLE M D Ph D

Measurements of Protection against Radiation K G Zimmer Strahlentherapie, 1937, 59, 671

Adequate protection in radiological departments is very important. The author undertook therefore, a series of measurements to determine the amount of radiation present in places where the personnel would be exposed to it. He describes the apparatus which consisted of a condenser ionization chamber and an electrometer. The technic of the measurements is outlined in detail. He demonstrates that systematic tests often reveal inadequate protection and consequently excessive exposure for the operator.

ERNST A POHLE, M D Ph D

RADIATION

Late Results of the Fractional Protracted Dose Method J Borak Strahlentherapie 1937, 58, 560

The author compares simple fractionation with protracted fractionation in roentgen therapy of malignant disease. After an analysis of his clinical observations he concludes that both methods are equal from a therapeutic standpoint. He cannot see any superiority of the fractionation with very small intensities. Furthermore, the economical factor is so important as to deserve serious consideration.

ERNST A POHLE M D Ph D

Development, Principles, and Biological Foundations of Methods of Radiation Therapy G Schwarz Strahlentherapie, 1937, 58, 499

This is a very complete historical sketch of the development of radiation therapy, beginning with the first therapeutic attempt in 1896 up to the present time. Because of the enormous wealth of information contained in this article it does not lend itself to abstracting but is recommended for study in the original (118 references to the literature).

ERNST A POHLE M D Ph D

Cell Permeability and Effect of Irradiation F Ellinger Strahlentherapie, 1937, 58, 464

In order to study the physiologic effect of ultra-violet light the author exposed collodion membranes to the radiation emitted by a quartz mercury vapor lamp for 15 minutes at 25 cm distance. Methyl-orange was chosen as indicator. He found that there is a definite increase in the permeability of the membrane after irradiation, a phenomenon which had been observed on living cells. This effect of irradiation cannot be regarded, therefore, as a characteristic property of living substance but may be explained by changes of the potential in the membrane.

ERNST A POHLE M D, Ph D

The Simple Fractional Dose Method in Radiation Therapy E Weber Strahlentherapie 1937, 58, 557

For economic reasons the author developed a modification of the Coutard method, retaining the protraction which, in his opinion is the principal factor. Technic: 180 kv, 4 ma, 0.5 mm Cu + 1 mm Al, 30-35 cm FSD, 25 r/min. In undifferentiated types of carcinoma the duration of treatment amounts to 20 days and in the differentiated types to about 45 days. His experience, extending now over a period of five years, tends to show that with the modified method the skin and epithelial reactions are the same as with the original method of Coutard. While good results were obtained in carcinoma of pharynx, larynx and mouth, little benefit was seen in inoperable carcinoma of the thyroid, the esophagus, the lung, and recurrent carcinoma of the breast.

ERNST A POHLE M D Ph D

The Saturation Method in the Treatment of Malignant Disease with Special Consideration of Holfelder's Modification H Holfelder Strahlentherapie 1937, 58, 523

The author discusses the principles of the saturation method as proposed originally by Kingery and Pfahler. The correction of the figures given by Pfahler based on Reisner's investigations are explained. The Coutard method is compared with the treatment technic developed at the author's clinic. Because his results have been excellent, Holfelder sees no reason for giving up

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ERNST A. POHLE, M D, Ph D

Occurrence of a Sarcoma in the Scar of a Surgically Removed Roentgen Carcinoma. K. Güting. *Strahlentherapie*, 1937, 59, 687

In 1932 the author reported a case of roentgen carcinoma which had developed on the dorsum of the hand. Following its surgical removal, the patient remained well for two years. At that time a new growth appeared in the scar, of red color and mushroom shape. Other carcinomas developed on the third and fourth fingers of the same hand. All tumors were removed. Histologic examination verified the diagnosis of roentgen carcinoma of the growth on the third and fourth fingers, but the recurrent growth in the scar was now a fibrosarcoma which showed canceroid pearls (three photomicrograms). No theory is offered explaining this change from a primary roentgen carcinoma to a sarcoma two years after operation. The patient has been well for two years.

ERNST A. POHLE, M D, Ph D

RADIATION THERAPY

Experiments with the Rotation Method in Roentgen Therapy. F. Dessauer, K. Lion, and M. Gökmen. *Strahlentherapie*, 1937, 60, 546

This is a preliminary report concerning a new treatment method for deep seated malignancies. It is based on the rotation of the patient's body during the exposure, with the diseased tissue placed in the rotation axis. It is possible to administer a much larger dose in the depth without injuring the skin. A few case reports are briefly quoted to demonstrate the advantages of the rotation method.

ERNST A. POHLE, M D, Ph D

Twenty Years of Roentgen Therapy. M. Lüdin. *Strahlentherapie*, 1937, 60, 483

This is a very interesting review of 2,908 patients subjected to irradiation during 1916-1935 at the Roentgen Institute of the University of Basel. While it is not suitable for abstracting and should be studied in the original, the following data based on 1,665 selected cases are submitted to give an idea of the tremendous material discussed and critically evaluated. The report is based on 457 cases of tuberculous cervical adenitis, 113 cases of peritoneal tuberculosis, and 197 of various types of tuberculosis, 29 cases of malignant struma, 112 cases of hyperthyroidism, 27 of hypophyseal tumors, 12 of tumors of the salivary glands, 5 cases of hypertrophy of the prostate, 117 of arthritis deformans, 18 of bursitis calcarea, 63 cases of carcinoma of the bronchus and of the lungs, 4 cases of actinomycosis of the lungs and

pleura, 40 cases of bronchial asthma, 79 cases of diseases of the nervous system, 130 cases of erysipelas, 10 of thrombophlebitis, 11 of polycythemia, 4 of essential thrombopenia, 42 cases of chronic myeloid leukemia, 24 of chronic lymphatic leukemia, 9 of acute leukemia, 12 cases of aleukemic lymphadenosis, 3 of aleukemic myelosis, 2 cases of tuberculosis of the spleen, 61 cases of lymphogranulomatosis, 84 cases of sarcoma, including melano-, lympho-, round-cell, spindle-cell sarcoma and glioma. Roentgen injuries are also briefly discussed.

ERNST A. POHLE, M D, Ph D

RADIOLOGY, PRACTICE OF

Roentgen Rays and Gross Structure of Matter. W. H. Bragg. *Strahlentherapie*, 1937, 58, 193

This is the German translation of the fifteenth MacKenzie-Davidson Lecture given by the author. The English translation will be found in the 'British Journal of Radiology' 1935, 8, 144.

ERNST A. POHLE, M D, Ph D

RADIUM

Physical Foundations of Emanation Therapy. S. Meyer. *Strahlentherapie*, 1937, 58, 656

The author supplies data on the method of administering radium emanation, how long it remains in the body and how it is excreted. He considers inhalation, administration *per os* either in solution or in substance, bath, and radon ointments and oils.

ERNST A. POHLE, M D, Ph D

Dosimetric Problems in Radium and Roentgen Therapy. H. Smereker. *Strahlentherapie*, 1937, 58, 676

The author describes the results of his measurements done with a carbon chamber on an apparatus for telerradium therapy containing 3 grams of radium. Data are also given for a smaller model containing 400 mg of radium. The average dose for a carcinoma varied from 8,900 to 12,500 r. Thyrotoxicosis is given 1,300 r and epithelioma in the corner of the eye 7,800 r. A special cone for contact therapy is also described.

ERNST A. POHLE, M D, Ph D

The Problem of Radium Dosimetry. The Photographic Method. W. Friedrich, U. Henschke, and R. Schulze. *Strahlentherapie*, 1937, 60, 22

The authors undertook a thorough study of the accuracy of the photographic method in radium dosimetry. They found that if carried out properly it is reliable and sufficiently accurate for practical purposes. Up to a certain point the degree of blackening is directly proportional to the dose. The quotient blackening/ionization depends on the filtration; if the dose is determined close to the radium screen through thin filters it has to be considered. The method previously described by Holthusen and his co-workers was also



Fig 2 Oil immersed induction-coil with multi section tube

next developed an 800,000-volt generator and 4-section glass tube combination which has proved very satisfactory in two such installations. These have been operated at 10 ma but were designed for 30 ma in case as much intensity as that were desired.

The tube design employed was such that we have never succeeded either in the field or in the laboratory in puncturing the glass envelope. In the laboratory we have taken a single section of this tube which in service has to stand only 200,000 volts and have repeatedly arced it over with 300,000 volts even with heavy condenser discharges, without being able to injure it.

The focusing action in the various sections is such that practically the entire milliamperage leaving the cathode passes through the intermediate electrodes to the anode. The focal spot size is controlled magnetically by a focusing coil.

The tubes in these outfits were originally used without filament bias but with a considerable amount of what might be called geometrical bias incident to focusing. Rose (3) reports that with filament bias on one of these outfits he has been able to raise the r-output per ma approximately 35 per cent. His absorption curves indi-

cate also a slight increase in hardness with electrostatic filament bias.

Within the above-mentioned limits of voltage and current, the main objections to these outfits are their cost and size, the latter calling for a special building instead of permitting installation in existing hospital rooms.

The facts that tubes can be so designed as to operate just as well on A-C as on rectified current and to give almost the same quality of radiation on A-C as on constant potential D-C lead one to consider very seriously the simple system of a tube connected directly to an A-C source.

One of the least expensive A-C sources is the induction coil, whose operation by the aid of a tube circuit can be made just as regular as that of a transformer. The coil is cheaper than the transformer for two reasons. It requires fewer secondary turns and can be made smaller because of the greater dielectric strength of insulating materials for very steep wave fronts.

In its simplest form, with a straight core, the induction coil has certain disadvantages, however. In the first place its external magnetic field necessitates the use of an insulating tank, and this, in turn means that for protection from electric shock a considerable amount of space must be kept free around the outfit.

Furthermore, the stray magnetic field introduces a complication in connection with the problem of focusing the tube. We (4) first became acquainted with this in a cathode ray outfit, (see Fig 2) in which we had mounted a multi-section tube close to an induction coil, connecting the intermediate electrodes of the tube to proper taps in the secondary. The large stray magnetic field of the open core seriously interfered with focusing. Later experiments have shown however, that a tube placed close to a coil can be so oriented with respect to the coil that the field does not interfere.

On the whole, the disadvantages of the coil over the transformer seem to outweigh the advantages and lead one to choose the latter.

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ERNST A. POHLE, M.D., Ph.D.

Twenty Years of Roentgen Therapy M. Lüdin Strahlentherapie, 1937, 60, 483

This is a very interesting review of 2,908 patients subjected to irradiation during 1916-1935 at the Roentgen Institute of the University of Basel. While it is not suitable for abstracting and should be studied in the original, the following data based on 1,665 selected cases are submitted to give an idea of the tremendous material discussed and critically evaluated. The report is based on 457 cases of tuberculous cervical adenitis, 113 cases of peritoneal tuberculosis, and 197 of various types of tuberculosis. 29 cases of malignant struma, 112 cases of hyperthyroidism, 27 of hypophyseal tumors, 12 of tumors of the salivary glands, 5 cases of hypertrophy of the prostate, 117 of arthritis deformans, 18 of bursitis calcarea, 63 cases of carcinoma of the bronchus and of the lungs, 4 cases of actinomycosis of the lungs and

pleura, 40 cases of bronchial asthma, 79 cases of diseases of the nervous system, 130 cases of erysipelas, 10 of thrombophlebitis, 11 of polycythemia, 4 of essential thrombopenia, 42 cases of chronic myeloid leukemia, 24 of chronic lymphatic leukemia, 9 of acute leukemia, 12 cases of aleukemic lymphadenosis, 3 of aleukemic myelosis, 2 cases of tuberculosis of the spleen, 61 cases of lymphogranulomatosis, 84 cases of sarcoma, including melano-, lympho-, round-cell, spindle-cell sarcoma and glioma. Roentgen injuries are also briefly discussed.

ERNST A. POHLE, M.D., Ph.D.

RADIOLOGY, PRACTICE OF

Roentgen Rays and Gross Structure of Matter W. H. Bragg Strahlentherapie, 1937, 58, 193

This is the German translation of the fifteenth MacKenzie-Davidson Lecture given by the author. The English translation will be found in the "British Journal of Radiology" 1935, 8, 144.

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Physical Foundations of Emanation Therapy S. Meyer Strahlentherapie, 1937, 58, 656

The author supplies data on the method of administering radium emanation, how long it remains in the body and how it is excreted. He considers inhalation, administration *per os* either in solution or in substance, bath and radon ointments and oils.

ERNST A. POHLE, M.D., Ph.D.

Dosimetric Problems in Radium and Roentgen Therapy H. Smereker Strahlentherapie, 1937, 58, 676

The author describes the results of his measurements done with a carbon chamber on an apparatus for telerradium therapy containing 3 grams of radium. Data are also given for a smaller model containing 400 mg of radium. The average dose for a carcinoma varied from 8,900 to 12,500 r. Thyrotoxicosis is given 1,300 r and epithelioma in the corner of the eye 7,800 r. A special cone for contact therapy is also described.

ERNST A. POHLE, M.D., Ph.D.

The Problem of Radium Dosimetry The Photographic Method W. Friedrich, U. Henschke and R. Schulze Strahlentherapie, 1937, 60, 22

The authors undertook a thorough study of the accuracy of the photographic method in radium dosimetry. They found that if carried out properly it is reliable and sufficiently accurate for practical purposes. Up to a certain point the degree of blackening is directly proportional to the dose. The quotient blackening/ionization depends on the filtration, if the dose is determined close to the radium screen through thin filters it has to be considered. The method previously described by Holthusen and his co-workers was also

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The question of whether it is better to use sealed-off tubes or continuous pumping depends upon various circumstances, as it is one of economics, convenience, and mechanical flexibility. In those cases in which it is merely a matter of economics the answer will depend mainly upon the life of the sealed-off multi-section tube—a factor which is as yet unknown.

I have so far referred largely to the work of our own laboratory and to what are to-day modest voltages—500,000 to 1,000,000.

Succeeding speakers will tell you of other tubes and other types of generator for this voltage range.

For the future attainment of the highest possible voltages two paths are open. One of these, which we owe to Dr. Van de Graaff, will be described by him. The other is the impulse generator, employing the Marx circuit.

The range of the impulse generator has already been carried to 10,000,000 volts and it would apparently be a perfectly straightforward engineering and manufacturing job to build one for several times this voltage. Other things in its favor are the increased electrical strength of insulators for impulses of short over those of long duration and the fact that such generators require no electrostatic shielding from corona, for the simple reason that they make available such large instantaneous current values that corona losses become negligible in comparison.

Brasch and Lange (6) in Germany have used the impulse generator together with a novel type of gas tube for voltages up to 2,400,000.

The disadvantages of the impulse generator for x-ray production would seem to be

(1) It is not well adapted to use with a hot cathode tube, as for example, to give an average current of a milliamperere it would call for a cathode having an emission

of perhaps 1,000,000 ma (Brasch and Lange seem to have been able to get this high emission from the cathode of a gas tube).

(2) The very high instantaneous energy values make severe mechanical demands on a target, and one would expect to find that a focal spot enormously greater than is now generally used with D.C. or 60-cycle A.C. would be required to give reasonable target life.

With these limitations of the impulse generator type of x-ray outfit in mind, it would seem as though the future production of the shortest possible x-ray wave lengths would be brought about through the use of some form of electrostatic generator and multi-section hot-cathode tube. This seems especially true for the experimental therapeutic application if, as now seems likely, only a milliamperere or less of current would be used with such high voltages.

It has been suggested that therapeutic results might be better if enormously greater instantaneous x-ray intensities than are now available were used—intensities of a different order of magnitude, say a million times as great, producing a much greater concentration of ions in the irradiated tissues. If this should be confirmed, some type of condenser machine and gas tube would seem to be indicated. In this connection Dr. Kingdon, of our laboratory, has found that very high instantaneous values of x-ray intensity may be obtained by the discharge of a large condenser through a highly evacuated tube containing a tungsten target and a cathode consisting of liquid mercury maintained at 0°C (7).

Immediately upon initiation of the discharge through such a tube, mercury vapor is produced by positive ion bombardment of the mercury cathode. This vapor liberation takes place in the path of the discharge, where it is ionized, thus giving rise to further positive ion bombardment of the cathode with the liberation of more electrons and the production of more vapor. This runaway effect is needed to

Carcinoma Tongue—Radium Treatment and its Technic S B Cooper Jour Indian Med Assn, September, 1937, 6, 665-670

The tongue is attacked by squamous-cell carcinoma of which there are two varieties one which produces cell nests and the other which does not. The tumor may be papillary, nodular, ulcerous, or fissured. Age incidence is from 41 to 72, and while no part of the tongue is exempt, most tumors occur on the anterior and lateral margins. Chronic infection and irritation, as from carious teeth, play an important part in the etiology. Diagnosis must be confirmed by microscopic examination and syphilitic lesions ruled out.

Treatment is directed to the primary lesion by the implantation of radium needles and the glands in the neck are dealt with by block dissection. The local lesion is surrounded by needles each containing 1.33 mg radium element, the filtration of each needle being 0.5 mm platinum. Total dose averages 1,200 mg hr. Strict oral hygiene is maintained and four weeks after the radium treatment the block dissection of the neck is done. If affected glands are found, external irradiation of the neck is given several weeks later by means of x ray or a radium collar using, roughly, 10,000 mg-hr.

J C RODICK, M D

Contribution to the Treatment of Hemangioma by Means of Radio-active Substances R Muller Strahlentherapie, 1937 59, 602

The author reports 39 cases of hemangioma observed in his clinic since 1934. Ten of his patients were males and 29 females, most were between five months and three years old. The treatments were usually given over a one-year period, first with from six to eight weeks and then three months between sittings, 10 mg radium screens, 1.4 cm long filtered through 2 mm Ag, also 0.5 mm Pt, with one milligram per square centimeter of skin surface, were used. Occasionally removable seeds were required; they contained 0.5 mc per cm length with a wall thickness of 0.1 mm Au. They were inserted 1 cm apart and left in the tissue up to 60 hours. A last method consisted of the application of radon screens filtered through 0.5 mm brass, 0.4 mc per sq cm was given per sitting. Re-examination of all treated patients did not reveal any radiation injuries. Thirty five of the children were entirely cured, two considerably improved, and only two received no benefit from the treatment.

ERNST A POHLE, M D, Ph D

RICKETS

A New Zone of Destruction in the Shoulder Blade in Rachitis Henry Kilian München med Wchnschr Aug 27, 1937, 84, 1362

To the previously observed zones of destruction the author adds one found in the scapula, occurring in the thinned bone half-way between the inferior angle and

the spine. The cause is the disproportion between the strength of the bone and the mechanical strain of the muscle pull. The lamellary bone, poorly built to withstand mechanical strain, is repaired by spotty ossification. This in the roentgenogram has the appearance of a solution of continuity, which in contrast to fracture is smooth. Clinically no findings are noted, and the classical signs of fracture are absent. When the rickets heals, a laying down of calcium in the zone of destruction occurs. The roentgenogram then shows dense calcium shadows, indicating that the calcium is deposited in the thickened osteoid bed.

L G JACOBS, M D

ROENTGENOLOGY, HISTORY OF

Medical Roentgenology around 1900 A Köhler Strahlentherapie, 1937, 60, 283

The author, who is well known to American radiologists, has written an interesting historical sketch describing the status of roentgenology about thirty-seven years ago. The technical facilities available then are briefly discussed as well as the first publications. Both diagnostic and therapeutic phases are considered and because the author speaks from his own experience the article has an attractive personal note.

ERNST A POHLE, M D, Ph D

ROENTGEN-RAY THERAPY

A Definition of the Technical Factors in Roentgen Therapy with Small Focal Skin Distances and its Differentiation from Other Similar Methods H Chaoul Strahlentherapie, 1937 59, 533

The author discusses his technic of roentgen therapy with relatively low potentials (60 kv, 2 mm Cu), short FSD (5 cm) and high doses (10,000-15,000 r), because in some clinics the method has not been strictly adhered to, and therefore the results were not as good as with the original method.

ERNST A POHLE, M D, Ph D

ROENTGEN SICKNESS

The Systemic Effect of Roentgen Rays, with Special Consideration of a Shocking Effect Produced by Histamine or Histamine-like Substances E Forfota Strahlentherapie, 1937, 59, 843

The author continued his studies reported in a previous paper regarding the relation between histamine and radiation sickness ('Strahlentherapie,' 1937, 59, 258). Prophylactic administration of histamine prevented radiation sickness in animals. He suggests, therefore, that this substance be given a trial in the treatment of human radiation sickness.

ERNST A POHLE, M D, Ph D

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The author considers the question as to whether or not these reactions are merely local or of a systemic nature and consequently affect the entire blood vessel system. In his opinion reactions of the type described remind one more of the sensitizations which are, for instance, seen after administration of barbituric acid and its derivatives.

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TUMORS (THERAPY)

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CALCIFICATION AND OSSIFICATION OF THE KIDNEY

A REVIEW OF THE LITERATURE AND A REPORT OF CASES

By A E GOLDSTEIN, M D, and B S ABESHOUSE, M D, *Baltimore, Maryland*

From the Urological Service, Sinai Hospital, Baltimore

PART I—INTRODUCTION

ALTHOUGH the literature is replete with many articles dealing with tuberculous calcification of the kidney, relatively little has been written on the subject of non-tuberculous calcification and ossification of the kidney. The majority of text-books and monographs on urology and urological roentgenology fail to mention the occurrence of these conditions and reference to these phenomena is found only in isolated case reports or in cases reported in connection with some other pathological lesion, *i e*, cysts, tumors, stones, pyonephrosis, etc.

Our interest in this subject was engendered by several interesting cases which presented calcified shadows in the renal regions in the roentgenogram and offered extremely difficult problems in differential diagnosis. Further impetus was the finding of minute areas of calcification in the kidney which were discernible only on cross-section or microscopic examination of specimens removed at operation for renal lithiasis, pyonephroses, tumors, etc.

For many years calcification has been the subject of much pathological and experimental investigation. In the latter half of the past century, excellent contributions to this subject were made by Virchow, Cohnheim, Czech, Von Kossa, and others. With the dawn of the new century, interest in this fascinating study was stimulated by the notable contributions of Askanazy, Verse, Gierke, Klotz, Tanaka and Katase, and later by the work of Wells, Schmidt, Hofmeister, Lubarsch, and others. In the past few years our knowledge of the chemistry of calcification has been enhanced and extended by the investigations of Howland and his associates on calcium deposits in normal and rachitic bones, and

by physico-chemical studies of normal and abnormal changes in the calcium and phosphorus content of tissues and body fluids by Holt, Rabl, Klenman, Barr, Albright, and others. It is not the intention of the authors to attempt a detailed summation of these studies on calcification in this paper, but rather to present a brief review of the more pertinent facts and theories concerning normal and pathological calcification in general and more specifically to discuss the pathogenesis of calcification in the kidney. Those interested in physiological, physical, and chemical aspects of calcification are referred to the excellent and comprehensive studies of Wells, Schmidt, Barr, Albright, and others.

In the human body, calcification occurs either as a physiologic or pathologic process. Physiological calcification is the normal process concerned with the deposition of calcium salts in the development and the formation of bone. Pathological calcification includes the deposition or precipitation of calcium salts in those tissues or organs which ordinarily do not contain calcium deposits or concretions.

Although several types of pathological calcification have been described, it is extremely difficult to classify them from an etiologic or pathogenic standpoint due to the fact that a precise or satisfactory explanation of the various types of pathological calcification is not always possible or else lacks confirmation and conviction. For practical purposes, we prefer to classify pathological calcification under two main headings, namely, (a) metastatic and (b) non-metastatic. The distinguishing factor is the fact that in metastatic calcification the deposition of calcium salts presumably takes place in normal or uninjured tissues, whereas the non-metastatic

areas over the spleen, which had received only 50 r. Pigmentation was still visible three months after the treatment. Another patient, who received 4,000 r in fractional doses over the thyroid (carcinoma), suffered from infection of the entire area after she had scratched a small region in the margin.

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Kleinman has offered an inclusive theory to explain both the metastatic and dystrophic types of calcification. It is his contention that all calcium deposits in tissues begin with the formation of crystals of tertiary calcium phosphate, and that deposition of these crystals is caused by local or general conditions which produce changes in the calcium and phosphorus concentration and the degree of alkalinity in the blood serum and tissue fluids. The localization of the calcium deposits is determined by the increased alkalinity of certain tissues, *ie*, devitalized tissues in cases of dystrophic calcification, and the stomach, lungs, and kidneys in cases of metastatic calcification.

In 1926, Leriche and Policard stated that the deposition of calcium takes place in connective tissue of low metabolism if the blood supply is diminished, particularly in the presence of hypercalcemia. Jones and Roberts (1934) maintained that there is normally a balance between the calcium content and the vascularity of mesenchymatous tissues which they believed was probably associated with phosphatase activity, and that any disturbance in this balance led to pathological changes (calcification) within the affected tissues. Gray (1935) reduced the blood supply to the kidney in rabbits by the ligation of one or more branches of the renal arteries and fed the animals a diet calculated to produce hypercalcemia. He found the deposition of calcium was more marked in the severer grades of renal damage resulting from extensive or total deprivation of blood supply.

The exact physico-chemical changes involved in the deposition of calcium in the various types of pathological calcification remains a matter of conjecture and controversy. As early as 1907, Klotz maintained that calcium deposits occurred as the result of the hydrolysis of fat which resulted in the formation of insoluble calcium soaps. The latter were converted by the action of carbonic acid into calcium phosphate and carbonate with the liberation of fatty acids. In 1911, Wells main-

tained that pathological calcification was due to either the deposition of calcium salts from the blood directly into the tissues or the precipitation of calcium salts in the excretory or secretory passages of the body. He was of the opinion that the vital factor in pathological calcification was the CO_2 content of the tissues and circulating fluids. He also pointed out that other factors may play a supplementary rôle in calcification, namely, (1) utilization of the proteins of the blood by starving or injured tissue, resulting in a disturbance of the solubility of calcium, and (2) the formulation of a substance or substances, *ie*, phosphoric acid, fatty acids, or protein, in the degenerated area having a special affinity for calcium.

In 1923, Robison demonstrated the presence of an active enzyme, phosphatase, in tissues undergoing calcification and ossification such as bone, ossifying cartilage and tissues, which become the site of calcium deposits such as the kidney. This enzyme aided in the process of calcification by its hydrolyzing effect upon the phosphoric ester which is found in the blood and tissue fluids and whose calcium salt is soluble in plasma and water. The increased concentration of PO_4 ions resulting from the enzyme reaction causes a precipitation of the carbonate molecule. Martland showed that the activity of this enzyme is dependent upon the H-ion concentration of the tissue fluids. He also demonstrated the presence of another phosphatase enzyme in the blood corpuscles and the existence of a delicate balance between the latter enzyme and the H-ion concentration of the tissue fluids. Kay has shown that the kidney possesses a high phosphatase activity which is greater in the cortex than in the medulla. No calcification occurs in the kidney with its high phosphatase activity when the blood calcium is at the normal level, but in the presence of hypercalcemia renal calcification is observed. Kay also pointed out that the phosphatase content of the blood plasma is markedly raised in certain generalized bone diseases, *ie*, osteitis

RADIOLOGY

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THE PRODUCTION OF X-RAYS OF VERY SHORT WAVE LENGTH¹

By W D COOLIDGE, PH D, *Schenectady, N Y*

THANKS to the initiative, vision, and courage of the medical pioneers, the therapeutic application of the x-rays was started very soon after their discovery.

It is interesting to see how rapidly the new knowledge derived from more recent fundamental physical research has been usefully applied to the further development of the art of radiology.

It is also interesting to note the extent to which modern physical science must be invoked to explain the various processes involved in the production, mensuration, and therapeutic application of the x-rays.

If we start with the electrons caroming about under thermal agitation in the filament spiral of the cathode, we first see them liberated thermally and then driven by the electrostatic field, and directed by means of an electrostatic electron lens, toward the target.

During their flight we are unable to keep track of them very satisfactorily. For, in accordance with the principle of indeterminacy, we cannot know accurately both the velocity and the position of a given electron at any instant of time, because the energy which the electron would have to give up to signal its position would reduce its velocity.

¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

The kinetic energy of the electron when it reaches the target is proportional to the potential difference between the electrodes. But its velocity does not increase as rapidly as the potential difference, being held down by an increase with velocity of the electron mass, and not allowed to exceed the velocity of light, in accordance with the relativity principle.

The moving electrons behave in some respects like particles and in other respects as a wave motion. They possess kinetic energy in virtue of their motion, which is a corpuscular property, and yet when they strike a thin metal film they are diffracted in identically the same manner as waves and it is possible to calculate a magnitude, the de Broglie wave length, which is inversely proportional to the velocity. It is the existence of this dualism in the nature of both energy and matter that has given rise to the most recent development in theoretical physics—that of quantum mechanics.

Arrived at the target, the rapidly moving electron encounters the electric forces due to the electrons and positively charged nuclei of the atoms which go to make up the target metal. It may make a direct hit with a nucleus near the surface of the target in which case its kinetic energy is transformed into a light quantum—in this case an x-ray having the minimum

tively insoluble salts Pauli and Samec showed that calcium in the form of calcium phosphate and calcium carbonate is far more soluble in a colloidal albuminous solution than in water Holt, La Mer, and Chown maintained that neutral calcium phosphate is present in the blood and in saturation up to 200 per cent, but believed that it is transported as the more readily soluble acid carbonate and acid phosphate which are easily converted into the neutral salts This theory of supersaturation has been substantiated by Sendrey and Hastings but questioned by Klinke and others Kramer and Shear maintained that the blood serum is actually undersaturated for Ca HPO_4 and that the calcium and phosphate ions are so combined in the tissue fluids The existence of tertiary calcium phosphate in the blood serum is doubted by many investigators since $\text{Ca}_3(\text{PO}_4)_2$ is not a known mineral and is unstable in water Other investigators, particularly Gassman and Klement, maintain that calcium phosphate and carbonate exist in the body fluids as a complex or combined salt Barille stated that calcium is found in the blood serum as unstable double salt, calcium carbonphosphate, which is soluble only at normal blood concentration of CO_2 , and dissociates into its two neutral constituents, calcium phosphate and calcium carbonate, when the CO_2 content is reduced Greenberg and Schmidt showed at the p_H of the body, the protein fraction of calcium in the serum is bound to casein in a complex non-ionized form It is generally accepted that the amount of calcium in the blood serum is greater than can be held by a salt solution of similar phosphate and carbonate content even after deducting the protein fraction It is also agreed that the equilibrium of the solution of the calcium salts may be easily upset by disturbances in the concentration of calcium, phosphate, phosphatase, and CO_2 of the body fluids

The Chemical Composition of Calcium Deposits—Barr has pointed out that analytical studies of calcification reveal the presence of calcium phosphorus carbonate

magnesium, small traces of alkaline salts, and occasionally traces of iron and silica The two chief constituents of all calcium deposits are calcium phosphate and calcium carbonate Howland and his associates found the ratio of residual calcium to residual phosphorus in fresh and old bone was 1.94, the ratio necessary for the formation of tertiary calcium phosphate $\text{CO}_3(\text{PO}_4)_2$ Kramer and Shear analyzed normal bone and pathological calcifications and found all the ratios averaged 1.96 Barr has shown that the constant presence of calcium phosphate and carbonate in all calcifications and the approximate constancy of their relative amounts has led to the assumption that these two salts are combined in definite proportion to form a compound or giant molecule, as hypothesized by Hoppe-Seyler, in 1877, and substantiated by the recent studies of Taylor and Sheard, Bogert, Hastings, and others

Classification of Calcification of the Kidney—The aforementioned classification of pathological calcification may be readily adapted to the different types of renal calcification We have classified renal calcification into three distinct types, as follows

I Metastatic calcification of the kidney (*Kalkmetastasen*) which occurs in those various bone diseases accompanied by a hypercalcemia

II Non-metastatic calcification associated with a renal lesion which causes a decreased solubility of the calcium salts of the blood and tissue fluids or results in the faulty or impaired excretion of calcium salts from the kidney—the so-called *Kalkgicht* of Schmidt

III Non-metastatic (dystrophic) calcification associated with a renal lesion in which the precipitation of calcium salts occurs in tissues presenting degenerative, vascular, or retrogressive changes

In Type I, the essential factor is an increase in the calcium salts of the blood which is due to the absorption of these salts from the bone lesions The majority of these cases develop in the absence of a renal lesion

In Type II, the important factor is a

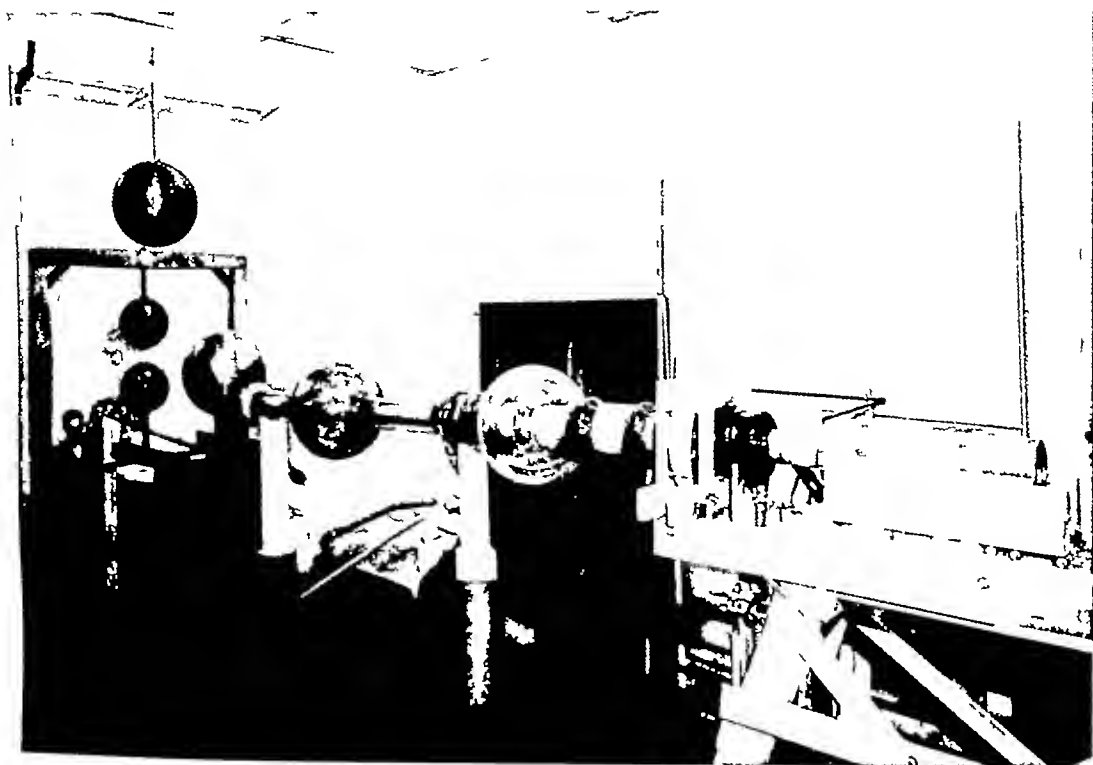


Fig 1 Early induction-coil X-ray outfit with multi-section tube, used experimentally at voltages up to 900 000 and subsequently used therapeutically for over two years at 700,000 volts

One of the first experimental outfits which we built for voltages much in excess of 200,000 consisted of a special induction coil with mercury turbine interrupter and a large two-section tube (1). This outfit, shown in Figure 1, operated continuously at 700,000 volts and was tested up to 900,000, it labored under the disadvantages attendant upon the use of a mechanical interrupter.²

The operation at the Memorial Hospital, in New York City, for a two- or three-year period of this experimental induction coil outfit was quite educational. It showed, among other things, the desirability, in cases in which continuous pumping of the tube was employed, of having something better than the mercury diffusion pump with its attendant liquid air trap. Away from the laboratory it

proved too difficult to maintain the liquid air in the trap for a prolonged period, at the proper level. And when this was not done, the water vapor and carbon dioxide which had been gradually accumulated there in the trap would return to the inner surfaces of the tube to delay the next following operation.

The full appreciation of this difficulty led to the rapid adoption, as soon as it became available, of the oil vapor diffusion pump which required only a water-cooled or a charcoal trap.

Furthermore, the tube was punctured occasionally by operating it at a time when, for one reason or another, the vacuum was too poor. This emphasized the desirability of developing a design which should be puncture-proof no matter what the vacuum and no matter what the electrical characteristics of the high voltage generator.

With transformers, kenotrons, and condensers connected in the Villard circuit, we

² Many unsuccessful attempts were made later to develop a circuit in which vacuum tubes could be made to fulfill its function more satisfactorily than did the mechanical interrupter. This was finally accomplished (2) but has not yet been used commercially.

predilection for these organs becomes more striking when one considers that calcification rarely occurs in these organs independent of a local lesion. In 1913, Hoffermeister maintained that metastatic calcification occurred in those organs whose tissues possess a high alkalinity which is obtained by the continuous excretion of acids, i.e., CO_2 in the lungs, HCl in the stomach and orthophosphoric acid in the kidneys, thus leaving the tissue more alkaline. He also pointed out that calcium salts are less soluble in an alkaline than in an acid medium. Ordinarily the amount of calcium in the blood is too slight to be precipitated, but when supersaturation of calcium salts occurs as a result of absorption of these salts from the skeleton, precipitation takes place in those organs where the alkalinity of the tissue fluids is greatest or the CO_2 concentration the least.

It is generally recognized that the principal factor influencing metastatic calcification is an increase in the calcium content of the blood, i.e., hypercalcemia. This increase of calcium in the blood is the result of extensive destruction of the bone.

Various experiments have been undertaken to reproduce metastatic calcification. Tanaka (1911) and Katsube (1913) showed that the intraperitoneal subcutaneous or intravenous injection of calcium salts, $\text{Ca}_3(\text{PO}_4)_2$, or $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$, resulted in calcification of organs distant from the site of injection which had only a partial resemblance to the clinical metastatic calcification. Dixon and Hoyle, Kreitzmar and Moll, Smith and Elvove, and others obtained calcification of the lungs, kidneys, and heart as a result of the hypercalcemia caused by the rapid decalcification of the bone following the administration of irradiated ergosterol. Metastatic calcification of the kidney has been observed following the administration of parathionone by Huepner (1927), Jaffe, Bodansky, and Blair (1931), and Moehlig, Murphy, and Reynolds (1935). Rabi observed typical metastatic calcification in his experimental studies by the alternate addition of acid or alkali to a high calcium diet.

(1) *Osteitis Fibrosa Cystica*—Osteitis fibrosa cystica, often spoken of as "osteitis fibrosa," was first described by von Recklinghausen in 1891. The relationship of the bone changes in osteitis fibrosa cystica to parathyroid hyperplasia (adenoma) was emphasized by Barr, Bulger, and Dixon (1929), who called the clinical syndrome "hyperparathyroidism."

The presence of calcium metastases in osteitis fibrosa cystica was first reported by Askanazy (1903). Gangele (1907) observed calcium deposits together with stones in the ureter and pelvis, causing hydronephrosis and pyelonephritis, in a female 37 years of age, dying of uræmia. Other cases of calcium metastases in osteitis fibrosa cystica have been reported by Meyer (1917), Hoffmeyer (1925), Parricra and Castro Friere (1926), Pencecke (1926), Akerberg (1927), Barr and Bulger (1930), Ask Upmark (1931)—two cases, Berner (1931), Bergstrand (1931), and Noble (1932). Ettinger and Magendantz (1934), Albright and Bloomberg (1935), and MacCallum. The calcium metastases were accompanied by renal calculi in the cases reported by Hoffmeyer, Parricra and Castro Friere, Noble, Barr and Bulger.

In 1934 Albright, Burd, Cope, and Bloomberg reviewed the renal complications in 83 cases of hyperparathyroidism. They distinguished three distinct groups, viz. (1) kidney disease, i.e., pyelonephritis, secondary to the formation of calcium phosphate stones in the renal pelvis, (2) acute parathyroid poisoning with anuria and accompanied by calcium deposits in the kidney and other organs in the absence of chronic parenchymatous changes in the kidneys, and (3) an intermediate group in which the kidney disease (chronic glomerular or vascular nephritis) was due to calcium deposits which occurred in the kidney and not in the other organs. There were 21 cases in the first group, 17 in the third, and one in the second.

The pathology and pathogenesis of metastatic calcification of the kidney in osteitis fibrosa cystica (hyperparathyroidism) has been the subject of comprehensive



Fig 3 Outside of recently developed oil-immersed 500,000-volt x-ray outfit

simplicity, is the accessibility of the target, which, for therapy, can, when desired, be brought very close to the patient, and, for industrial use in metal radiography, be inserted into cavities. This accessibility of the target also makes possible the attainment of x-ray protection with a minimum amount of lead.

The development work on this type of outfit has been as yet largely confined to a size which is being tested in continuous operation at 550,000 volts and 10 ma.

The overall height of the outfit is 4 feet.

The secondary of the transformer consists of a large number, some 76, thin coils. The lower end of the secondary is grounded. The secondary is surmounted by a large hollow metal toroid and the cathode end of the tube is let into this toroid. A few turns of wire within the toroid furnish current to the cathode filament and this current is controlled by a rheostat mounted in the toroid and operated from without by a motor-driven shaft of insulating material. Toroidal metal shells surrounding the tube and electrically connected to the intermediate electrodes shield the tube from the external radial field due to the grounded metal tank.

Outfits of this type can doubtless be developed for higher voltages by increasing the dimensions. Furthermore, various studies which we have under way lead us to

a man 44 years old who had also sustained six fractures. They considered the formation of calculi as calcium metastases in both cases, due to a disturbance of hormonal equilibrium with a resultant disturbance of calcium metabolism.

We have recently described six cases of renal calculi in osteitis deformans, but unfortunately were able to study the kidneys histologically only in one case showing numerous small stones and a severe pyelonephritis but no calcium deposits. We have been unable to find any case reports of calcium metastases in the kidney in this disease.

(C) *Rickets and Renal Rickets*. There are relatively few references to occurrence of metastatic calcification in either of these diseases. Gierke (1902) and Schmorl (1904) mentioned the occurrence of calcium metastases in rickets. In 1907 Glaserfeld studied the incidence of metastatic calcification of the kidney in 70 autopsies on children and found calcium deposits in the kidneys of 10 of the 49 children with rickets. Reference has already been made to the interesting case reported by Litterki and Denkin. Chown (1936) reported a case of calcium deposits in the kidney of an infant who had had pyuria, bacilluria, and marked crumetobes. In 1936, Butler, Wilson, and Farber reported a case of late rickets in a 10-year old boy who had diffuse calcification of the pyramids of both kidneys (confirmed by operation). An analysis of the calcified material showed a calcium carbonate phosphate compound of the same composition as bone. Albright, Dienes, and Sulkowitch observed a similar case.

In 1883, Lucas called attention to the association of chronic renal disease with marked deformities and alterations in the growth of bones in five cases. This syndrome has been designated as "renal rickets," whereas "renal dwarfism" is employed to denote the small stature and stunted growth that may accompany chronic interstitial nephritis in early life. In 1930, Mitchell pointed out that a disturbed relation between the calcium and

phosphorus of the blood may exist in renal rickets usually in the form of hypocalcemia, the reverse of the conditions in hyperparathyroidism. Mitchell observed a heavy amorphous deposit of calcium salts in the tubules and pelvis of each kidney in a case of renal rickets. Lightwood (1932) reported extensive calcium deposits in the kidneys of a female infant of seven months, a case of renal dwarfism associated with calcosis and arterial calcification. Ellis (1935) observed also a case of calcium deposits associated with renal dwarfism in a six-year old boy who had no complaint of urinary symptoms. Chown (1936) reported calcium deposits in the kidneys of two sisters who died in early infancy, suffering from severe congenital renal rickets. Asher noted calcification in the kidney in infantism with bony changes resembling rickets.

It is generally assumed that renal disease, present in renal rickets, causes the bone lesions. However, Chown suggested that the reverse may be true, viz. the hypercalcemia due to the bone disease causes the nephritic lesion. The renal disease usually manifests itself as a chronic interstitial nephritis (nephrosclerosis) with intratubular and peritubular calcium deposits which may be accompanied by varying degrees of acute or chronic pyelonephritis or congenital anomalies.

(D) *Osteosclerosis*—This disease, also known as Albers-Schonberg disease or marble bones, occurs most frequently in adults but is occasionally seen in children. The disease process is characterized by an excessive calcification of the bones, with an increased fragility and, in addition, there is found extensive metastatic calcification in the lungs, arteries, and tendons. The kidney may occasionally show metastatic calcification, as in the case reported by Schultze.

(E) *Myeloma*—The occurrence of calcification in the kidney as well as in the gastric mucosa and alveolar walls of the lungs in a case of myeloma was first noted by Bender in 1902. Perla and Hutner (1935) studied the renal changes associated

One of our latest developments comprises what seems like a very attractive and in some respects novel type of transformer outfit (5) In this, both tube and high voltage source are in the same grounded metal tank of oil, thus giving complete electrical protection The outside of such an outfit is shown in Figure 3 The high voltage source is a simple 60-cycle transformer in which the magnetic circuit is opened just enough so that the inductance of the primary, for the frequency in question, balances the capacitance of the secondary As a result of the electrical tuning secured in this way the power factor is high and the primary current correspondingly low

The tube is connected directly to the transformer and must then rectify the current In the absence of transformer tuning this would result in making the inverse voltage appreciably higher than the useful With the tuned transformer, however, there are circulating currents in the secondary which are so large compared with the few milliamperes of rectified current supplied to the tube that there is but little difference between the useful and inverse voltages

The multi-section tube for this outfit is made up of several glass cylinders each $3\frac{1}{2}$ inches in diameter and $\frac{1}{4}$ inches long These are sealed to the metal rings carrying the intermediate electrodes These metal rings are of Fernico, an alloy which accurately matches in its heat expansion, over a wide temperature range, that of the glass cylinders The metal extension chamber carrying the target is similarly sealed to the last glass cylinder We are using 100,000 volts per section Such tubes are sealed off from the pump, can apparently be made for any voltage, and give promise of having a long life

Flexibility in the application of the outfit is increased by making the whole tube rotatable about its length axis

As the target is grounded, it can be cooled with tap water

An attractive feature of the outfit, in addition to its relatively small size and

description of calcium deposits in the kidney it was believed that these changes were always associated with bone disease. In 1901, Beer collected records of 12 cases associated with bone disease and 22 cases unassociated. Beer reviewed 100 autopsies and found 53 cases of calcium deposits in the kidney associated with various diseases among which was chronic nephritis. He pointed out that calcium deposits were found only in diseased kidneys and stressed the influence of local changes in the kidney, either nutritional or toxic in origin, upon the deposition of calcium salts.

As early as 1882 Kidd reported extensive calcium deposits in the kidneys of two males aged 34 and 40 years respectively who had chronic renal disease. In 1891 Brill and Libman described a case of calcification of the kidney associated with calcification in the liver in a 14-year old girl who died of chronic interstitial nephritis. In 1920 Schmidt maintained that the decrease of albumin in the blood, which occurred as a result of increased excretion through the chronic nephritic kidney, altered the solubility of the calcium salts in the blood and influenced the deposition of these salts in the kidney. He described the presence of fine granular deposits of calcium salts in the interstitial tissue and tunica propria of the tubules, following hyaline degeneration in the kidney of senile individuals.

Recent clinical investigations by Greenwald, Nelson and Stenmetz, and others have disclosed a marked disturbance in calcium and phosphorus metabolism in the various affections of the kidney. The most notable changes in the calcium and phosphorus content of the blood in chronic nephritis are (a) an appreciable lowering of the serum calcium and an elevation of inorganic phosphates, and (b) the serum calcium is inversely proportional to the amount of urea and inorganic phosphates.

Weiss (1922) reported a case of chronic nephritis accompanied by extensive tubular deposits of calcium in both kidneys and nephrolithiasis in one of the kidneys of a

14-year old girl. Bergstrand (1923) described a case of renal insufficiency with cortical atrophy (chronic glomerular nephritis) caused by heavy deposits of calcium in the papilla. In this case he also observed small cystic degenerative areas in the papilla containing minute calcareous particles. Several of these cystic areas communicated with the pelvis and were responsible for the presence of loose calcareous particles in the pelvis.

(B) *Nephrosis* - In 1930, Patrassi made a comprehensive review of the subject of calcification in Bright's disease, reporting his observations in 41 cases of calcium deposits in a series of 183 cases with renal disease. He found calcium deposits in 18 of 43 cases of tubular nephritis, in one of 10 cases of acute and subacute glomerulonephritis, in eight of 17 cases of chronic glomerulonephritis with secondary sclerosis, in 11 of 58 cases of primary renal sclerosis, and none in 20 cases of renal affections other than Bright's disease, i.e., renal tuberculosis, acute pyelonephritis, etc.

(C) *Primary Sclerosis (Arteriosclerosis)* - Katt (1895) was the first to describe the presence of heavy deposits of calcium in the cortex of primary sclerotic kidneys. Bamm (1900) observed calcification of the glomeruli in senile atrophic kidneys due to arteriosclerosis. The incidence of such changes is greater than formerly supposed, a fact substantiated by Patrassi's findings. The calcium deposits are found in the tubules and glomeruli. This type of cortical calcification belongs to the dystrophic group and is due to the deposition of calcium in the various component structures in the renal cortex which present retrogressive changes, i.e., hyalinization, fibrosis, degeneration resulting from the primary vascular sclerosis.

(D) *Experimental Nephritis* - Calcium deposits in the kidney have been produced experimentally by general intoxication with the following substances (1) aloes (Gottschalk, Neuberger), (2) bichloride of mercury (Virchow, Schmidt, Verse and others), (3) bismuth subnitrate (Langhans,

- (2) WESTENDORP W F General Electric Review,
to be published soon
- (3) ROSE JOHN E and LOUGHRIDGE, D H
Cathode Bias for Supervoltage Tube RADIOLOGY
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- (4) COOLIDGE W D DEMPSTER, L E, and TANIS
H E, JR Physics, 1931 1, 243
- (5) CHARLTON E E HOTALING GEORGE WESTEN-
DORP, W F and DEMPSTER L E An Oil immersed
X ray Outfit for 500 000 Volts and an Oil immersed
Multi section X ray Tube RADIOLOGY September
1937 29, 329-340
- (6) Naturwissenschaften 1930 18, 765, 766
- (7) KINGDON K H Phys Rev, 1938, 53,
128-134

ful recovery Following the operation, the patient returned for regular and periodic treatment of his prostatic and right renal infections, which have been completely eradicated

The operative specimen revealed the surface changes of a chronic pyelonephritis including several small cortical cysts On cross-section, an abscess 8 mm in diameter was found in the medullary area in the central portion of the kidney The abscess contained thick pus and minute calcareous fragments When these were washed away, calcareous particles were found lining the walls of the abscess cavity

3 *Tuberculosis*—The deposition of calcium salts in tuberculous lesions of the kidney is considered a part of the pathological process of this disease and is a relatively common finding From a pathological standpoint, the nature of the calcium deposits varies in the different types of renal tuberculosis and for practical purposes may be classified under two general headings (a) the deposition of calcium salts in solitary or multiple ulcerative lesions situated at or near the tips of the pyramids, and (b) calcification of single or multiple caseated areas in the parenchyma with or without involvement of the renal pelvis and ureter

The pathological significance of calcification in the renal tuberculous lesions has been the subject of much conjecture Some investigators consider calcification as representing a stage of healing, while others believe it is part of the general repair process The latter view appears to be more logical and conforms with the general pathological concept that any dead or damaged tissue, so large that it cannot be readily absorbed, may become infiltrated with calcium salts In a similar manner the deposition of calcium salts in the caseated and necrotic tissue of tuberculous lesions may be interpreted as an attempt to wall off the infectious process The calcium salts are obtained from the circulation and are not the result of specific cell differentiation (metaplasia)

That calcification of a renal tuberculous lesion is not genuine evidence of healing is corroborated by the fact that active tubercle bacilli may be found within completely calcified areas

The incidence of calcification in renal tuberculosis is relatively high Unfortunately, accurate histological studies on calcification in renal tuberculosis are not available but undoubtedly would yield an even greater incidence than the following roentgenographic statistical studies

Caulk (1915) reported some degree of calcification in 20 per cent of the cases of renal tuberculosis Braasch and Olsen (1919) reported that pre-operative roentgenographic studies were made in each of the 131 patients operated upon for renal tuberculosis at the Mayo Clinic in 1916 and 1917, and positive shadows suggestive of renal tuberculosis were present in 30 cases (22 per cent) Stevens (1926) found typical shadows due to tuberculous calcification in seven of 15 consecutive cases in which roentgenograms were taken Crenshaw reviewed 1,817 cases of renal tuberculosis at the Mayo Clinic from 1910 to 1928 and found 131 cases (7.1 per cent) with calcification The incidence of calcification is even greater in cases of occluded renal tuberculosis, as evidenced by the fact that Crenshaw found calcification in 30 per cent of the occluded type in the series of 1,817 cases The greater incidence of calcification in the occluded type of renal tuberculosis is attributed by Braasch to the fact that such lesions are of longer duration and hence have more opportunity for calcification

Gibson has pointed out calcification is even more frequent in cases of true autonephrectomy, *i.e.*, asymptomatic cases with occlusion of the ureter with total destruction and transformation of the kidney into a calcified mass Crenshaw found total calcification in 10 cases (0.5 per cent) in the series of 1,817 cases The duration of illness in cases showing complete calcification of the kidney is striking Birkelo reported a case in which the primary illness dated back 43 years In Gibson's

give the tube sufficient current-carrying capacity, but mustn't be too great as otherwise the voltage will fall off too rapidly with the result that most of the current flow will take place after the voltage has become too low for the production of useful x-rays

BIBLIOGRAPHY

- (1) COOLIDGE W D DEMPSTER, L E and TANIS H E JR A High Voltage Induction Coil and Cascade Tube Roentgen-ray Outfit Am Jour Roentgenol and Rad Ther February, 1932 27, 405-414
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and many pus cells and red blood cells. Stained smear of urinary sediment was negative for tubercle bacilli, but guinea pig inoculation was positive. Cystoscopic examination was essentially negative except for congested right ureteral orifice. Plain roentgenogram showed several irregular areas of calcification within the right kidney outline. A ureteropyelogram showed a normal pelvis but the terminal calices were irregular and moth-eaten in appearance (Fig 1). The areas of calcification appeared to involve the pyramids of the kidney. The patient was treated with usual palliative measures.

Case III (G U 4,708), E H K, female, 48 years of age, married, was admitted to Sinai Hospital on May 18, 1935, complaining of pain in the right loin. Onset of present illness dated back three years, when she developed discomfort in the bladder region and had frequency of urination. She was examined by another physician who found pus in her urine. She complained of dull pain localized to the right lumbar region and right loin, which recurred at frequent intervals. Six weeks before she had had her first cystoscopic examination by another urologist, who found the pus coming from the right kidney. Intravenous urography failed to reveal any dye in the right kidney and no abnormal shadows were noted in the kidney. There was no history of renal colic or hematuria. Physical examination disclosed slight tenderness in the right upper and lower quadrants. A catheterized specimen of urine showed 15 to 20 pus cells and an occasional red blood cell. A stained smear showed several tubercle bacilli and many *B coli*.

Cystoscopy and pyelography were performed on the above date. The pus was found to be coming from the right kidney. A guinea pig inoculation was made with the urine which was later reported positive. Plain roentgenogram revealed several irregular calcified shadows in the right kidney region. The right pyelogram showed the pelvis to be slightly dilated and the ends of the lower and middle

calices were irregular and fuzzy in outline. The calcified shadows noted on the plain plate were found to extend outward from the tips of the calices and were considered to be evidences of calcification in old healing tuberculous abscesses (Fig 2). Nephrectomy was performed and the patient made an uneventful recovery.

Case IV (G U 5,823), H R, male, 31 years of age, married, was admitted to Sinai Hospital on March 12, 1936, complaining of pain on urination. The patient had always enjoyed good health except for cervical adenitis in 1921. For the past two years, he has noticed a urethral discharge due to a urethral stricture, he has been treated with dilatation with good results. In May, 1935, he had an attack of right renal colic and, following this, he had marked frequency, burning, and tenesmus. A tentative diagnosis of renal and vesical tuberculosis was made in February, 1936, and the patient received four injections of Koch's tuberculin. The urinary trouble has persisted to date. Physical examination was essentially negative except for several hard irregular nodules in both lobes of the prostate and in the right seminal vesicle. A voided specimen of urine gives a positive test for albumin and microscopically shows many pus cells and red blood cells. A stained smear shows numerous tubercle bacilli. Plain roentgenogram showed several calcified shadows in the right kidney region, also, there were several calcified shadows in the spleen and one irregular calcified shadow in the region of the right adrenal (Fig 3).

Cystoscopy revealed extensive involvement of the right kidney and the bladder around the right ureter. There was a marked decrease in function in the right kidney. On March 24, 1936, a right nephro-ureterectomy was performed. The patient developed a post-operative atelectasis of the right lung, it cleared up promptly, and he was discharged from the hospital on April 23, 1936.

The right kidney was very large and soft throughout on the posterior surface, there was a small hemorrhagic cyst, and several

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- (4) COOLIDGE, W D DEMPSTER, L E, and TANIS H E JR Physics, 1931 1, 243
- (5) CHARLTON E E, HOTALING, GEORGE WESTENDORP, W F, and DEMPSTER, L E An Oil-immersed X-ray Outfit for 500,000 Volts and an Oil immersed Multi-section X ray Tube RADIOLOGY, September 1937 29, 329-340
- (6) Naturwissenschaften 1930, 18, 765, 766
- (7) KINGDON, K H Phys Rev, 1938, 53, 128-134

small abscesses in the upper portion of the kidney which showed a more extensive involvement than the lower pole. On cross-section there was found an extensive ulcerative and caseative tuberculous process in the upper pole of the kidney. These large abscesses contained a thick greenish pus in which some calcareous material was observed and in the walls of the abscessed cavities. Histological study revealed typical changes of renal tuberculosis.

The diagnosis in this case was (1) renal tuberculosis, right, with calcification, (2) tuberculosis of both seminal vesicles, both vas deferens and the prostate, with calcification, (3) tuberculosis of the spleen, with calcification, (4) tuberculosis of the right adrenal gland, with calcification.

Case V (G U 5,084), B J R, male, 36 years of age, married, merchant, presented himself for examination on Jan 23, 1933, with a complaint of hematuria. He had always enjoyed good health until five weeks before, when he noticed blood in his urine. He called an urologist who made a diagnosis of renal tuberculosis. For the past five weeks he had been complaining of diurnal frequency, burning, and urgency. Physical examination was negative. Voided specimen of urine showed many pus cells and a few red blood cells. On Jan 24, 1933, cystoscopy and pyelography were performed, and a diagnosis of right renal tuberculosis was made. A plain roentgenogram showed several small calcified shadows in the region of the right kidney. A right pyelogram showed the right pelvis and upper major calyx to be normal. The terminal portions of the middle and lower major calices appeared to be compressed and had irregular fuzzy outlines. The calcified shadows appeared to be in the parenchyma beyond the terminal portion of the lower major calyx (Fig 4). On Feb 7, 1933, a right nephrectomy was performed. The patient was discharged from the hospital on Feb 21, 1933.

The operative specimen showed the kidney to be normal with small tubercles

on the anterior and posterior surfaces of the lower pole. On cross-section, there were several small ulcerated abscessed areas extending from the tips of the pyramids to the parenchyma. The abscesses contained numerous minute calcareous particles which imparted a gritty sensation under the knife. Microscopic studies showed typical findings of tuberculosis with calcification.

Case VI (G U 3,808), G W, aged 13 years, male, schoolboy, was referred for examination in 1928 because of pyuria. Following an attack of scarlet fever at the age of seven, his mother noticed that his urine was cloudy and occasionally contained large shreds of pus-like material. Two years later, he developed whooping cough and also showed pus in his urine. The patient did not complain of any pain or difficulty on urination, but frequently wet his bed at night. On May 12, 1928, he complained of pain localized to the right ureteral quadrant which did not radiate and lasted but ten minutes, being accompanied by nausea and vomiting. The pain recurred at frequent intervals during the following two days. Physical examination was entirely negative. A voided specimen of urine showed 50 to 60 pus cells per h p f.

Cystoscopy and pyelography were performed on June 18, 1928, and a diagnosis of right renal tuberculosis was made. The plain roentgenogram showed an irregular, large calcified shadow in the region of the right kidney, rather blotchy and simulating a bunch of grapes (Fig 5). The diagnosis of a right renal tuberculosis of occluded calcified type was made.

On July 6, 1928, a right nephrectomy was performed. The patient made an uneventful recovery and was discharged from the hospital on July 26, 1928. The operative specimen showed an irregular nodular mass which had a brownish color in some areas and pinkish in others. Some of the nodular areas were soft and others were firm. On cross-section, a thick yellowish-gray pus exuded. The entire kidney was replaced by large cavities filled

give the tube sufficient current-carrying capacity, but mustn't be too great as otherwise the voltage will fall off too rapidly with the result that most of the current flow will take place after the voltage has become too low for the production of useful x-rays ~

BIBLIOGRAPHY

- (1) COOLIDGE, W D, DEMPSTER L E and TANIS H E, JR A High Voltage Induction Coil and Cascade Tube Roentgen-ray Outfit. Am Jour Roentgenol and Rad Ther February 1932, 27, 405-414

small abscesses in the upper portion of the kidney which showed a more extensive involvement than the lower pole. On cross-section there was found an extensive ulcerative and caseative tuberculous process in the upper pole of the kidney. These large abscesses contained a thick greenish pus in which some calcareous material was observed and in the walls of the abscessed cavities. Histological study revealed typical changes of renal tuberculosis.

The diagnosis in this case was (1) renal tuberculosis, right, with calcification, (2) tuberculosis of both seminal vesicles, both vas deferens and the prostate, with calcification, (3) tuberculosis of the spleen, with calcification, (4) tuberculosis of the right adrenal gland, with calcification.

Case V (G U 5,084), B J R, male, 36 years of age, married, merchant, presented himself for examination on Jan 23, 1933, with a complaint of hematuria. He had always enjoyed good health until five weeks before, when he noticed blood in his urine. He called an urologist who made a diagnosis of renal tuberculosis. For the past five weeks he had been complaining of diurnal frequency, burning, and urgency. Physical examination was negative. Voided specimen of urine showed many pus cells and a few red blood cells. On Jan 24, 1933, cystoscopy and pyelography were performed, and a diagnosis of right renal tuberculosis was made. A plain roentgenogram showed several small calcified shadows in the region of the right kidney. A right pyelogram showed the right pelvis and upper major calyx to be normal. The terminal portions of the middle and lower major calices appeared to be compressed and had irregular fuzzy outlines. The calcified shadows appeared to be in the parenchyma beyond the terminal portion of the lower major calyx (Fig 4). On Feb 7, 1933, a right nephrectomy was performed. The patient was discharged from the hospital on Feb 21, 1933.

The operative specimen showed the kidney to be normal with small tubercles

on the anterior and posterior surfaces of the lower pole. On cross-section, there were several small ulcerated abscessed areas extending from the tips of the pyramids to the parenchyma. The abscesses contained numerous minute calcareous particles which imparted a gritty sensation under the knife. Microscopic studies showed typical findings of tuberculosis with calcification.

Case VI (G U 3,808), G W, aged 13 years, male, schoolboy, was referred for examination in 1928 because of pyuria. Following an attack of scarlet fever at the age of seven, his mother noticed that his urine was cloudy and occasionally contained large shreds of pus-like material. Two years later, he developed whooping cough and also showed pus in his urine. The patient did not complain of any pain or difficulty on urination, but frequently wet his bed at night. On May 12, 1928, he complained of pain localized to the right ureteral quadrant which did not radiate and lasted but ten minutes, being accompanied by nausea and vomiting. The pain recurred at frequent intervals during the following two days. Physical examination was entirely negative. A voided specimen of urine showed 50 to 60 pus cells per h p f.

Cystoscopy and pyelography were performed on June 18, 1928, and a diagnosis of right renal tuberculosis was made. The plain roentgenogram showed an irregular, large calcified shadow in the region of the right kidney, rather blotchy and simulating a bunch of grapes (Fig 5). The diagnosis of a right renal tuberculosis of occluded calcified type was made.

On July 6, 1928, a right nephrectomy was performed. The patient made an uneventful recovery and was discharged from the hospital on July 26, 1928. The operative specimen showed an irregular nodular mass which had a brownish color in some areas and pinkish in others. Some of the nodular areas were soft and others were firm. On cross-section, a thick yellowish-gray pus exuded. The entire kidney was replaced by large cavities filled

type of calcification occurs in tissues or organs which are the site of localized changes (*i e*, fatty degeneration, hyalinization, degeneration, or necrosis resulting from a toxic, circulatory, or metabolic disturbance) predisposing to the deposition of the calcium salts

Non-metastatic calcification may be further divided into the following groups, *viz* (a) dystrophic calcification, (b) calcinosis, (c) arterial calcification, (d) stone formation, (e) heterotopic ossification. The latter groups will be briefly discussed only insofar as they concern calcification of the kidney

Virchow (1855) stressed the etiological relationship of destructive bone diseases to a special type of calcification which he called metastatic calcification (*kalkmetastasen*). His observations were based on eight cases, all but one of which suffered from some destructive bone disease and were accompanied by a varying degree of nephritis, the exception being a case of nephritis unaccompanied by any bone disease. The type of bone disease varied and included osteomyelitis, tuberculous spinal caries, and osseous metastases from a sarcoma of the cheek and an epithelioma of the lip. He showed that the metastatic deposits of calcium salts exhibited a predilection for certain sites, particularly the kidneys, lungs, and stomach and were composed of the same salts which through resorption had disappeared from the bone lesions. He maintained that the important factor governing this abnormal deposition of calcium was the increase in the calcium salts in the blood and that a necessary secondary factor was the presence of a renal lesion which resulted in the faulty excretion of these salts through the kidney, and subsequent deposition in tissues devoid of any previous damage. The importance and significance of hypercalcemia in the production of metastatic calcification has been verified repeatedly in the experimental studies with parathormone and irradiated ergosterol.

It soon became apparent from the reports of Chiari (1878), Hlava (1882),

Kockel (1899), Kischensky (1900), Stadel (1901), and others that extensive calcification of soft tissues and organs, including the kidneys, occurred in the absence of destructive bone lesions and hypercalcemia, and that other factors undoubtedly played a rôle in the abnormal deposition of calcium. The rôle of nephritis as a primary factor in pathological calcification was emphasized by Schmidt in 1913. He described general calcification with involvement of the kidneys, the so-called *kalkgicht*, in cases of calcium gout without evident bone destruction. He pointed out that the decrease in the solubility of these calcium salts in the blood was caused by a decrease in the amount of albuminous substances in the blood which occurred as a result of the excretion of considerable quantities of albuminous substances by the damaged kidney. The albuminous substances and phosphates normally act as buffers to keep the calcium salts in solution and prevent the precipitation of these salts. Harbitz (1917) and Rabl (1923) also emphasized the rôle of calcium retention and disturbed acid-base equilibrium due to impaired renal function in cases of general calcification without bone destruction.

Dystrophic calcification is the most common type of pathological calcification encountered. It is generally agreed that any dead or damaged tissue, infected or uninfected, so large or so situated that it cannot be absorbed, may become infiltrated with calcium salts. The location and distribution of these calcified lesions are extremely varied inasmuch as every tissue and organ in the body is subject to retrogressive changes or lesions which predispose to the deposition of calcium salts. While it is readily apparent that this type of calcification is directly dependent upon local retrogressive changes, *i e*, fatty infiltration, hyalinization, necrosis, etc., which are the result of circulatory, toxic inflammatory or nutritional disturbances, the degree or extent of the calcification may be modified by general changes in calcium metabolism or in the amount of calcium in the blood or tissue fluids.

phrosis Very little of the kidney remained excepting a shell of fibrous tissue which was impregnated with a mortar-like substance composed of carbonates and phosphate of lime Morris (1885) stated that calculous material is often deposited upon the lining of the cavities of the pyonephrotic kidney McNaughton (1901) reported a case of right calculous pyonephrosis in a female which showed calcareous degeneration in the substance of the organ and calcium deposits lining the dilated calices Baetjer (1907) stated that a purulent exudate in the renal pelvis, when inspissated and containing deposits of calcium, may cast a shadow indistinguishable from that of a renal calculus He cited an unusual case in which a roentgenographic diagnosis of renal calculus (3 cm in diameter) was made, and, at operation, the pus was found to be encapsulated by fibrinous tissue lined with a thin layer of calcium salts Cases of calcification of hydronephrotic or pyonephrotic kidney have been reported by Goldenberg (1910), Groeschel (1912), Bauer (1913), Knerr (1918), and Arena (1920)

In a monograph on hydro- and pyonephrosis published in 1926, Hinman pointed out that not infrequently on cross-section of pyonephrotic kidneys, a thin pus escapes from the purulent cavities, leaving empty pouches and a dry semi-caseous material in which partial calcification exists He also emphasized the fact that there may be considerable calcareous changes in such a dead kidney and, as atrophic changes progress, the calcified areas may be somewhat absorbed A case of total calcification of the right kidney was reported by Wheeler in 1930 The condition was presumably a calcified pyonephrosis, as the patient gave no history suggestive of tuberculosis nor were any evidences of tuberculosis found on inoculation

Case VII (G U 3,229), A N, male, 61 years of age, married, tailor, was first seen on Aug 3, 1936, complaining of pain in the left side of the abdomen For the past two weeks he had been having fre-

quent chills, accompanied by a dull pain in the left upper quadrant The urine gave positive test for albumin and microscopically contained many pus cells and staphylococci The plain roentgenogram revealed a large irregular calcified shadow in the center of the enlarged right kidney, with several shadows of lesser density in the lower pole (Fig 6) The pyelogram showed a very large multilocular pyonephrotic kidney with calcareous deposits within the abscess cavities (Fig 7) On Aug 27, 1926, a left nephrectomy was performed under gas anesthesia The operative specimen showed a very large pyonephrotic kidney with numerous abscess cavities containing a thick inspissated greenish pus in which calcareous material was found The walls of these abscess cavities were also lined with calcareous fragments Microscopic study of the tissue surrounding these cavities showed marked chronic inflammatory and fibrotic changes, with heavy round-cell infiltration and deposition of calcium salts

Case VIII (G U 5,382), E L, female, 48 years of age, married, housewife, was referred for examination on June 18, 1934 Her chief complaint was backache of seven years' duration For the past year she had been troubled with a dull pain in the lower sacral and right lumbar region which occasionally radiated to the right upper quadrant She has also been troubled with urgency, diurnal and nocturnal frequency, and burning, but no hematuria Physical examination revealed tenderness in the upper and lower quadrants and lumbar regions on the right Urine contained many pus cells

Cystoscopy and pyelography disclosed a calculous pyonephrosis on the right The plain roentgenogram showed a large calcified shadow occupying the pelvis and the upper and middle major calices (Fig 8) In the lower pole of the kidney, there appeared to be several small shadows in the cortical area On June 26, 1934, a right nephrectomy was performed, following which the patient made an uneventful recovery

deformans, osteitis fibrosa cystica, osteomalacia, rickets, and renal rickets. In 1934 Rosenheim and Robison were able to produce calcification in the kidney, lung, and aorta *in vitro* by immersing these tissues, freshly excised from normal animals, in solutions containing calcium and inorganic and organic phosphorus. These calcium deposits closely resembled in appearance and distribution those described by Brand and Holtz in 1920, as occurring in experimental hypervitaminosis. In the kidney the calcium deposits *in vitro* were found in the cells and basement membrane of the tubules and were confined to a narrow zone in the cortex, substantiating Kay's observation in the distribution of phosphatase in the kidney.

The extremely variable degree of calcification observed in experimental and clinical conditions with hypercalcemia emphasized the difficulty of attempting to establish a predictable relationship between the degree of hypercalcemia and the deposit of calcium in the tissues. For example, Tanaka and Katase noted only patchy areas of calcification following the intravenous injection of large amounts of calcium, causing a transitory hypercalcemia. Staub observed calcification at or near the site of injection but no calcified changes in distant organs. In experimental ergosterol poisoning, Smith and Elvove obtained variable results, as indicated by the presence of extensive calcium deposits, with only a slight increase in the serum calcium in some cases, and the failure to demonstrate any perceptible increase of calcium in tissues in other cases with hypercalcemia. Shelling obtained calcification of the soft tissues, lungs, and blood vessels in rats with hypocalcemia induced by parathyroidectomy.

From the clinical and experimental evidence at hand it appears that any considerable increase in the concentration of serum phosphatase may disturb the equilibrium of calcium and cause a precipitation of calcium salts. Smith and Elvove found a definite relationship between calcification of the tissues and the phosphate

values in the serum in ergosterol poisoning. Albright and his associates found that in hyperparathyroidism the first change was a fall in phosphate values, followed by hypercalcemia, and maintained that these conditions persisted throughout the course of the disease and exerted a favorable influence on the deposition of calcium in the soft tissues.

The Nature of Calcium in the Blood and Tissue Fluids—From the studies of Klinke, Peters, Van Slyke, and Barr, particularly the latter, we have drawn the following pertinent facts and observations concerning the chemical state of calcium in the body fluids. The normal calcium concentration of human serum varies between 9.0 and 11.5 mgm per 100 cc of serum. This calcium level is not greatly influenced by the injection of calcium salts in large quantities. The injection of parathyroid extract produces hypercalcemia in the absence of any intake of calcium and in spite of the increased excretion of calcium incident to the injection of parathormone. The removal of the parathyroids results in a decrease in the calcium content of the serum, usually to less than one-half of the normal. It appears that parathormone is necessary to keep the calcium values of the tissues at their physiological levels. It is estimated that this hormone is responsible for holding in solution at least from 40 to 50 per cent (4 to 5.8 mgm) of the normal calcium content of the serum. According to Peters and Eiserson, another portion of the serum calcium, varying between 3 and 4 mgm, is bound to protein. A small amount of serum calcium, less than 25 per cent of the total, remains to be accounted for by the forces ordinarily governing the solubility of calcium in any solution of inorganic salts.

The amount of calcium salts dissolved in serum by the ordinary forces of solubility has been studied by many investigators. Barr has pointed out that analysis of the inorganic substances in tissue fluids indicates that calcium in simple solution exists chiefly in combination with phosphate and carbonate in the form of rela-

The operative specimen revealed a large coral calculus, brownish-black in color, occupying the pelvis and upper and middle calices. The lower major calyx was markedly dilated and contained thick greenish pus. When this was washed away, yellowish-brown calcareous material was found lining the abscess cavity. A stricture which was present at the uretero-pelvic junction was probably the etiological factor in the production of the calculous pyonephrosis.

Case IX (G U 1,23A), J M, male, 41 years of age, married, tin worker, was seen in consultation for the first time on Nov 28, 1930. He had been admitted to the hospital 12 days previously complaining of sharp pain in the right upper quadrant. Onset of present illness dated back 13 years at which time he had developed sharp pain in the right upper quadrant which radiated across the abdomen and up the right shoulder. The pain was accompanied by chills, fever, and nausea, but no vomiting. He had frequently passed "gravel" about the size of a pea and had been told he had pus in his urine. He had hematuria at least once a year which preceded or followed the passage of a stone. He also complained of dysuria, burning, and frequency during the attacks. The attacks of pain recurred at intervals of two or three days. The pain recurred with increasing severity and frequency and was attended by marked gastro-intestinal symptoms. He consulted a surgeon, who made a diagnosis of cholelithiasis and advised hospitalization.

Physical examination was essentially negative except for an ill-defined, slightly tender mass in the right upper quadrant. The urine contained from 30 to 40 pus cells and from 20 to 30 red blood cells per h p f.

On Nov 19, 1930, an exploratory laparotomy was performed. The gall bladder, stomach, and intestines appeared normal. In the right renal region there was a large mass, about the size of a child's head, which was interpreted as an enlarged kidney. Ten days later cystoscopy and pyelography revealed a non-functioning

calculous pyonephrosis on the right side with four irregular calcified shadows within the kidney (Fig 9).

On Dec 12, 1930, a right nephrostomy was performed and about one quart of thick green pus was removed. No stones could be palpated within the pyonephrotic cavities although several of the cavities were lined with calcareous material which had a gritty sensation against the exploring finger. A thoracotomy was done on Feb 20, 1931, after which the patient developed a draining sinus leading to the pleural cavity and another leading to the kidney. On Aug 18, 1931, a right nephrectomy was performed, after which he made an uneventful recovery except for a persistent fistula at the operative site. On Sept 14, 1933, a right ureterectomy and removal of necrotic tissue in the renal bed was performed in order to clear up the persistent renal fistula. The patient died twelve hours after the operation.

Histological study of the kidney revealed a heavy deposition of calcium salts in degenerative tissues containing evidences of acute and chronic fibrosis. There were no evidences of tuberculosis in any portion of the kidney.

Case X (G U 2,931), L R, female, 33 years of age, married, housewife, was referred for examination on July 13, 1925, with a complaint of pain in both kidney regions. The patient had enjoyed good health until three years before, when she developed in the right side a sharp and colicky pain which radiated to the right lower quadrant. Pain recurred at frequent intervals. About a year before, she had hematuria during one of the attacks, she also had an occasional dull pain in the right kidney region. Examination disclosed tenderness in both kidney regions, more marked on the left than on the right. Catheterized specimen of urine showed many pus and red blood cells. Cystoscopy and pyelography revealed a calculus in the pelvis of the left kidney and several small shadows near the periphery of the kidney. Pvelograms showed the larger shadow to be within

renal lesion which may be primary (*i.e.*, acute or chronic nephritis, arteriosclerosis) or secondary (*i.e.*, toxic degenerative nephrosis). Hypercalcemia is not essential to this type of calcification although the degree of renal calcification is more marked in those cases accompanied by a transitory or permanent increase in the blood calcium.

In Type III, the essential factor is also a renal lesion which may be of an infectious, obstructive, traumatic, or neoplastic character. Hypercalcemia does not play a primary rôle in this type of calcification.

In this paper the authors will confine themselves to a discussion and presentation of cases based upon the following classification:

Calcification of the Kidney

I Metastatic calcification — *Kalkmetastasen* (Type I)

- (A) Osteitis fibrosa cystica (hyperparathyroidism)
- (B) Osteomalacia, osteopsathyrosis, and osteitis deformans
- (C) Rickets and renal rickets
- (D) Osteosclerosis
- (E) Myeloma
- (F) Fractures
- (G) Lesion of the spinal cord
- (H) Primary osseous neoplasms and neoplastic osseous metastases

II Non-metastatic calcification — *Kalkgicht* (Type II)—associated with an acute or chronic nephritis

- (A) Acute or chronic nephritis
- (B) Nephrosis
- (C) Primary sclerosis (arteriosclerosis)
- (D) Experimental nephritis

III Non-metastatic calcification of the dystrophic type, *i.e.*, destructive or degenerative lesions of the kidney (Type III)

- (A) Acute or chronic infectious lesions
 - 1 Acute or chronic pyelonephritis
 - 2 Abscess of the kidney
 - 3 Tuberculosis
 - 4 Bilharziosis
 - 5 Perinephritis or paranephritis
- (B) Obstructive or degenerative lesions
 - 1 Hydronephrosis
 - 2 Pyonephrosis
- (C) Tumors of the kidney
 - 1 Cystic lesions
 - (a) Solitary cysts
 - (b) Echinococcus cysts

- (c) Perirenal and peripelvic cysts
- (d) Polycystic diseases
- (e) Congenital cyst
- (f) Dermoid cyst

2 Benign tumors

- (a) Fibroma and adenoma of the renal capsule

3 Malignant tumors

- (a) Hypernephroma
- (b) Sarcoma
- (c) Mixed tumors

(D) Vascular disease

- 1 Arterial calcification
- 2 Aneurysm of renal artery

(E) Injuries of the kidney

- 1 Intrarenal
- 2 Extrarenal
 - (a) Perirenal hematoma
 - (b) Perirenal and pelvic cysts
 - (c) Pseudohydronephrosis

(F) Renal lithiasis

- 1 Microlithiasis
- 2 Cortical stones
- 3 Putty-like bodies
- 4 Sandy material

IV Calcification of the kidney associated with gastro-intestinal diseases (Type II)

(A) Pyloric obstruction

- 1 Gastric or duodenal ulcer
- 2 Gastric or duodenal carcinoma

(B) Intestinal lesions

(C) Cirrhosis of the liver

(D) Dysentery

(E) Undetermined gastro-intestinal diseases

(F) Dietary deficiencies or faulty nutrition

V Miscellaneous group (Type II)

- (A) Leukemia and other blood diseases
- (B) Senile type

Ossification of the Kidney—Osseous Metaplasia

(A) Hydronephrosis or pyonephrosis

(B) Renal calculi

(C) Renal tumors

- 1 Cysts—solitary and echinococcus
- 2 Hypernephroma and sarcoma
- 3 Mixed tumors

(D) Vascular lesions

- 1 Endothelioma
- 2 Infarct

I METASTATIC CALCIFICATION

Cases of metastatic calcification in the kidney associated with bone diseases have been reported by Virchow, Askanazy, Beer, Hofmeister, and Wells. The most common sites of metastatic calcification are the lungs, stomach, and kidney. The

and guinea pig inoculation were negative for tubercle bacilli. A left pyelolithotomy was performed on April 1, 1932, and two years later the same kidney was removed.

The left kidney showed numerous abscesses throughout its cortex. On cross-section, a large stone was found in the pelvis, extending into the upper major calyx. There were numerous abscesses throughout the parenchyma, several of which contained calcareous material in the inspissated pus lining the walls of the abscessed cavities. Histological study showed acute and chronic pyelonephritis, with calcification in the walls of abscess cavities.

(C) *Tumors of the Kidney*—1 *Cystic Lesions*

(a) *Solitary Cysts*—The occurrence of calcification in the walls of a serous hemorrhagic cyst is a relatively uncommon finding. In 1885, Morris reviewed 2,610 autopsies at the Middlesex Hospital and found five solitary cysts, one of which, the size of a horse chestnut, observed in a 19-year-old patient, had calcified walls. In 1902, Albarran and Imbert stated that the fibrous walls of renal cysts may be infiltrated with calcium salts, but they presented no case reports. Haenisch is quoted by Arkin and Lepehne as reporting the first case of calcified cyst, in a 65-year-old male. The first report of a calcified cyst in the English literature was made by Case in 1915. The following year, Cunningham reported two calcified cysts in a series of 29 cases of small solitary cysts in the autopsy records of two Boston hospitals. Clute (1916) observed necrosis and secondary calcification of the cyst wall in two cases operated upon. In addition to the above cases, we have collected 22 cases from the literature, as follows: Israel and Israel (1925), Laquiere (1925), Kirwin (1926), Day (1928), Joseph (1928), Karris (1928), Latteri (1930), Byrum (1931), Colston (1932), 6 cases, Damm (1932), Melly (1933), Jones (1934), 2 cases, Herbst and Vynalik (1935), Barney (1936), Herskovitz (1936), and Mohr (1937). Several of the cases re-

ported by Colston are also published in Young and Waters' monograph on Urological Roentgenology, one of these cases was a personal case of the authors and is herewith reported in brief.

The etiologic rôle of trauma in the production of these calcified cysts is clearly demonstrated in the cases reported by Herbst and Vynalik, Day, and Colston. Colston was of the opinion that these calcified cysts arise in one of two ways either (a) from hemorrhage into a simple serous cyst, or (b) from the natural evolution of a perirenal hematoma. He maintained that calcification occurs as a result of degenerative processes which take place when the extravasated blood is not absorbed, *viz* the blood within the cyst coagulates, clots, and adheres to the walls of the cyst, and calcium salts are precipitated from the organized blood clots.

Case XII (G U 3,089), S B, white, male, 55 years of age, married, tailor, was admitted to the Sinai Hospital on the service of Dr Goldstein on Feb 2, 1926, complaining of a large mass in the right side of the abdomen and inability to walk properly. Twenty-five years previously the patient had been kicked by a horse in the right flank. Following this, a mass had appeared in the right flank which became slowly progressive in size but caused no distress until about six months before the patient came to us, when it began to interfere with locomotion. The patient had had no urinary symptoms.¹

On physical examination a solid irregular mass could be felt, extending across the mid-line, 5 cm below the crest of the ilium and upward underneath the costal margin. This mass was fixed, firm, and did not descend on inspiration. The urine was clear, negative chemically and microscopically. A plain x-ray film showed three huge, apparently intercommunicating cysts, with irregular areas of calcification in the walls, with a deep septum between the larger cysts. No kidney structure was visible (Fig 11). At operation

¹ For full details of this case see Colston's article.

study by Albright and his associates, and in the following descriptions we have drawn extensively from their excellent contributions. It is well to point out that while their observations deal specifically with the calcium deposits in the kidney in hyperparathyroidism, these same observations may be extended and applied to metastatic calcification of the kidney in the other destructive diseases of bone.

The calcium deposits in the intrarenal urinary passages may appear as minute spheroidal or punctate areas or linear masses. The minute punctate areas resemble white flecks or dots which are faintly discernible on the cut surface of the cortical tissue and are often confused with small areas or fatty degenerations or with gas bubbles in the stellate veins. The linear masses appear as white streaks in the papillæ running parallel to the tubules. These papillary deposits usually make the pyramids stand out clearly but occasionally bear a close resemblance to uric acid infarcts, which can be easily distinguished by chemical tests. The small punctate masses are rarely seen on the surface of the kidney. Occasionally the calcium deposits in the pyramids may be very extensive and appear in the roentgenogram as wedge-shaped shadows conforming to the outline of the pyramids, as occurred in the cases reported by Akerberg, Ettinger and Magendantz, and Albright, Baird, Cope, and Bloomberg. It appears that the size and extent of these calcium deposits varies with the duration and severity of bone destruction, the degree of hypercalcemia with its resultant disturbance in the crystalloid-colloid equilibrium of the blood and urine, and the degree of renal impairment.

The microscopic examination usually reveals characteristic findings in these cases of metastatic calcification, *viz* precipitation of calcium salts in the epithelium of the tubules and formation of calcium casts in the lumen of the tubules. Calcium deposits are found less frequently in the interstitial tissues and walls of the blood vessels, including the glomerular loops and

capsule. The presence of calcium in these deposits and casts is readily confirmed by using Von Kossa silver stain, which is specific for calcium salts and stains them black.

Albright and Bloomberg (1935) have stressed the intimate relation between the calcium deposits in the intrarenal urinary passages and the fine granular casts in urinary sediment of patients with hyperparathyroidism. These granular casts which are extremely fragile and composed chiefly of calcium phosphate, have the same appearance microscopically as amorphous phosphates and are similar in structure to the individual or conglomerate calcium casts found in the tubules in clinical and experimental hyperparathyroidism. They believed that the tubular casts are directly related to the formation of stones in hyperparathyroidism, and considered these casts as microscopic calculi in the tubules. In their opinion, the same factors, *i.e.*, concentration in the urine of calcium of phosphates and of hydrogen ions, govern the formation of these calcium casts as well as stone in hyperparathyroidism.

(B) *Osteomalacia, Osteopsathyrosis, and Osteitis Deformans*—There are very few reports of metastatic calcification in these bone diseases, despite the fact that frequent reference is made of their calcification. As early as 1854, Steibel and, in 1875, Senator commented upon the occurrence of calcium deposits in the kidney in osteomalacia. Schonenberger (1901) reported calcium infarcts in the kidney in a case of osteomalacia complicated by multiple sarcomas and multiple fractures. Oppenheimer (1923) found calcium metastases in the kidney in two cases of osteoporosis (osteomalacia) in his series of 34 cases. Taterka and Denkin (1927) reported a case of renal calculi and calcium metastases in a woman 37 years old, who had suffered from rickets in childhood and later showed distinct osteomalacic traits.

Taterka and Denkin also reported a case of concrement formation and calcium metastases following osteopsathyrosis in

polycystic disease but no areas of calcification were seen. A nephrocutaneous fistula was established. At the time of operation, several small calcareous bodies, varying in diameter from 1 to 3 mm, were found within some cysts, and in several areas calcium deposits were found lining the walls of cysts and in the interstitial tissue between cysts. Several pieces of tissues were removed for study and showed the typical histological changes of polycystic disease.

(e) *Congenital Cyst*—Uthoff (1936) reported a unique case in a female, four years of age, who had a solitary right kidney with a calcified renal cystic vestigial remnant which was seen in the roentgenogram and interpreted as a large pelvic calculus. At operation, a calcified cystic mass was delivered and extirpated. The mass was attached to the kidney by fibrous tissue and was completely devoid of any blood supply. No evidence of renal epithelium could be demonstrated.

(f) *Dermoid Cyst*—Calcification may also occur in dermoid cysts of the kidney. Valentine (1929) reported one case and collected eight cases from the literature. In four, cholesterol crystals were found; in six, an indefinite substance of varying color and consistency, often containing deposits of calcium salts, was found within the cysts or in the cyst walls. Fahre (1934) reported a dermoid cyst of the kidney which showed calcification on the roentgenogram.

2 *Benign Tumors*—In the older literature occasional mention is made of hyalinization and calcification in tumors of the renal capsule, *i.e.*, adenoma, fibroma, myoma. In 1908, Nurnberg reviewed a large series of benign renal tumors which included lipoma (7 cases), fibroma of capsule—*markfibroma*—(67 cases), fibromyoma and lipomyoma (122 cases), myosarcoma (13 cases), adenoma (66 cases), and angioma (4 cases). He observed calcium deposits within the tumor mass in the capsular fibromatous and adenomatous type of tumor. He also observed the frequent occurrence of cal-

cium deposits in the non-tumor-bearing areas of the kidney. One patient had two distinct tumors, namely, a fibroma of the capsule and a calcified cyst adenoma. Arkin (1926) stated that he had seen such cases at postmortem, but gave no further details. Fahr described calcium deposits in a tubular adenoma, the size of a walnut, in a patient with pulmonary tuberculosis.

3 *Malignant Tumors*—The attention of the urologists and roentgenologists was drawn to this interesting pathological change by Arkin's report, in 1926, of a case of calcification of a hypernephroma diagnosed by roentgenographic study. Prior to this report, experience with this pathological phenomenon was limited to the report of an occasional case observed at autopsy. The treatises on renal tumors by Albarran and Imbert and by Garceau fail to mention the presence of calcification in renal tumors.

(a) *Hypernephroma*—Calcification of the tumor tissue is most commonly observed in the so-called hypernephroma. The earliest report is by Albrecht (his Case 25), in 1905, who described pathological features of a hypernephromatous left kidney removed from a 58-year-old woman by Hochenegg, in 1903. He found two tumor masses in the lower pole of the left kidney: the lower mass, about the size of an apple, was surrounded by a dense calcified capsule; the second smaller tumor, nearer the pelvis, was surrounded by a dense fibrous capsule which was calcified in some places.

In 1908, Hall reported a case of hypernephroma (his Case XIII) in which an unusual degree of calcareous degeneration existed, but the pathological description was very meager. Pleschner (1914) presented a clinical and pathological study of 25 cases of hypernephroma and found only one case (his Case X) with calcification. This patient, 32 years old, had a large tumor in the left kidney region which was considered to be a large area of hydronephrosis, but, at operation, a hypernephroma was found and removed. Pathological study revealed deposits of calcium,

study by Albright and his associates, and in the following descriptions we have drawn extensively from their excellent contributions. It is well to point out that while their observations deal specifically with the calcium deposits in the kidney in hyperparathyroidism, these same observations may be extended and applied to metastatic calcification of the kidney in the other destructive diseases of bone.

The calcium deposits in the intrarenal urinary passages may appear as minute spheroidal or punctate areas or linear masses. The minute punctate areas resemble white flecks or dots which are faintly discernible on the cut surface of the cortical tissue and are often confused with small areas or fatty degenerations or with gas bubbles in the stellate veins. The linear masses appear as white streaks in the papillæ running parallel to the tubules. These papillary deposits usually make the pyramids stand out clearly but occasionally bear a close resemblance to uric acid infarcts, which can be easily distinguished by chemical tests. The small punctate masses are rarely seen on the surface of the kidney. Occasionally the calcium deposits in the pyramids may be very extensive and appear in the roentgenogram as wedge-shaped shadows conforming to the outline of the pyramids, as occurred in the cases reported by Akerberg, Ettinger and Magendantz, and Albright, Baird, Cope, and Bloomberg. It appears that the size and extent of these calcium deposits varies with the duration and severity of bone destruction, the degree of hypercalcemia with its resultant disturbance in the crystalloid-colloid equilibrium of the blood and urine, and the degree of renal impairment.

The microscopic examination usually reveals characteristic findings in these cases of metastatic calcification, *viz* precipitation of calcium salts in the epithelium of the tubules and formation of calcium casts in the lumen of the tubules. Calcium deposits are found less frequently in the interstitial tissues and walls of the blood vessels, including the glomerular loops and

capsule. The presence of calcium in these deposits and casts is readily confirmed by using Von Kossa silver stain, which is specific for calcium salts and stains them black.

Albright and Bloomberg (1935) have stressed the intimate relation between the calcium deposits in the intrarenal urinary passages and the fine granular casts in urinary sediment of patients with hyperparathyroidism. These granular casts which are extremely fragile and composed chiefly of calcium phosphate, have the same appearance microscopically as amorphous phosphates and are similar in structure to the individual or conglomerate calcium casts found in the tubules in clinical and experimental hyperparathyroidism. They believed that the tubular casts are directly related to the formation of stones in hyperparathyroidism, and considered these casts as microscopic calculi in the tubules. In their opinion, the same factors, *i.e.*, concentration in the urine of calcium of phosphates and of hydrogen ions, govern the formation of these calcium casts as well as stone in hyperparathyroidism.

(B) *Osteomalacia, Osteopsathyrosis, and Osteitis Deformans*—There are very few reports of metastatic calcification in these bone diseases, despite the fact that frequent reference is made of their calcification. As early as 1854, Steibel and, in 1875, Senator commented upon the occurrence of calcium deposits in the kidney in osteomalacia. Schonenberger (1901) reported calcium infarcts in the kidney in a case of osteomalacia complicated by multiple sarcomas and multiple fractures. Oppenheimer (1923) found calcium metastases in the kidney in two cases of osteoporosis (osteomalacia) in his series of 34 cases. Taterka and Denkin (1927) reported a case of renal calculi and calcium metastases in a woman 37 years old, who had suffered from rickets in childhood and later showed distinct osteomalacic traits.

Taterka and Denkin also reported a case of concrement formation and calcium metastases following osteopsathyrosis in



Fig 12 (upper left) Case XIV Pyelogram of left kidney showing compression elongation and distortion of the lower major calyx produced by a hypernephroma The arrow points to a calcified shadow in the lower portion of the tumor mass The favorable prognostic significance of calcification in hypernephromas of the kidney is substantiated by the fact that this patient enjoyed good health for seven years following nephrectomy but in the eighth year developed parotid orbital and pulmonary metastases which proved fatal

Fig 13 (upper right) Case XV Pyelogram showing obliteration of the upper major calyx and compression and distortion of the middle major calyx due to a hypernephroma of the upper pole of the right kidney The arrow indicates an area of calcification in the tumor mass

Fig 14 (lower left) Case XVI Pyelogram showing the characteristic deformities of the pelvis and calices produced by a hypernephroma in the upper pole of the right kidney The arrows indicate two large calcified shadows present in the periphery of the tumor

with Bence-Jones proteinuria and multiple myeloma, and found 36 cases in the literature with description of kidney changes. They reported two personal cases with calcification of the tubules and collected eight similar cases. They maintained that there are three characteristic pathological changes in the kidney of multiple myeloma, no one of which is constant but all three may be present, *viz* (1) arteriosclerosis of the kidney, (2) nephrosis, (3) calcium deposits in the renal tubules. It seems highly probable that the injury to the tubules, caused by the nephrosis, predisposes to the deposition of calcium in the tubules.

(F) *Fractures*—In a recent paper entitled "Urinary Calculi in Bone Diseases," we studied the development of renal calculi following fractures of the bony pelvis and long bones. At that time it was apparent that a variety of local and constitutional changes may accompany or follow any fracture and serve as predisposing factors in the formation of renal calculi and calcium deposits in the kidney. While the explanation of the latter phenomenon is not always available, a causative relation may be assumed in the presence of the following conditions: (a) renal lesion antedating the fracture or occurring at the time of injury or originating through complicating infections, (b) temporary or permanent disturbance in the crystalloid-colloid balance in the blood and urine which may be due to decalcification of injured bone, prolonged immobilization, infection of the injured bone, delayed or poor healing, etc.

Reports of metastatic calcification associated with fractures are rare. Akerberg (1932) reviewed the subject and found relatively few cases, due possibly to the reluctance or disinterest on the part of urologists and pathologists to report isolated cases.

(G) *Lesions of the Spinal Cord*—Myer has reported metastatic calcification of the kidney and dystrophic calcification and ossification of the muscles of the lower extremities following transverse lesions of the spinal cord. He attributed the

calcium deposits in the kidney in these conditions to withdrawal of calcium from the paralyzed extremities and to the calcium content of the blood. He maintained that the calcium was transported chiefly by the lymphatic vessels as seen in roentgenograms of fractures, articular tuberculosis, and Gritti's amputations. Undoubtedly, the presence of an ascending cystopyelitis resulting from the bladder paralysis, with its attending stasis and infection, plays some rôle in the development of metastatic renal calcification. The secretory function of the kidney is impaired as a result of these infectious changes, and the increased alkalinity of the renal tissue caused by the elimination of acids favors the precipitation of calcium salts which are present in the blood and tissues in an excessive amount.

(H) *Primary Osseous Neoplasms and Neoplastic Osseous Metastases*—Primary osseous neoplasms and osseous metastases from a carcinoma or sarcoma may produce extensive destructive lesions in the bones, with subsequent disturbances in the calcium metabolism. These latter changes predispose to the formation of calcium deposits in various organs in the body, particularly in the presence of an accompanying nephritis. Metastatic calcification is observed more frequently in cases of secondary osseous metastases from a carcinoma (Verse, Hastings *et al*, Klotz, Harris) or sarcoma (Litten, Lazarus and Daresdau, Stade, and Askanazy) than in primary neoplastic diseases of the bone. In many of these cases the metastatic calcification may be extensive but rarely involves the kidneys. Adamson, Boyd, and Cameron observed a case of extensive calcium deposits in the kidney due to destruction of the bone by metastatic bronchogenic carcinoma in an 18-year-old male.

II NON-METASTATIC CALCIFICATION

(*Calcification Associated with Acute or Chronic Inflammatory Diseases of the Kidney (Kalkgicht), Type II*)

(A) *Acute or Chronic Nephritis*—For many years following Virchow's original

two hours but which was accompanied by urgency, frequency, and hematuria

Physical examination was negative except for a round smooth mass in the right upper quadrant about the size of a large grapefruit. A voided specimen of urine was negative for albumin and sugar and microscopically showed three to four pus cells per h p f. A tentative diagnosis of hypernephroma was made which was confirmed by cystoscopy and pyelography. The plain roentgenogram showed a calcified shadow in the region of the upper pole of the right kidney, while the pyelogram showed compression and distortion changes in the upper and middle major calices, typical of a renal tumor. The calcified shadow was situated within the tumor mass (Fig 13). On Oct 19, 1928, the right kidney and tumor were exposed through a lumbar incision and the condition was found to be inoperable. The ureter was ligated. The patient made an uneventful recovery. Following discharge from the hospital, he became progressively weaker and died on April 26, 1930.

Case XVI (G U 6,672), M B, female, 50 years of age, married, housewife, was admitted to the surgical service of the Sinai Hospital on May 30, 1933, with the complaint of dull pain in the right upper quadrant of six weeks' duration. The urine was negative except for an occasional pus cell. A tentative diagnosis of chronic cholecystitis was made.

On June 5, 1933, an exploratory laparotomy was performed but the gall bladder and gastro-intestinal tract appeared normal. A large mass about the size of an adult's head, considered to be a hypernephroma, was palpated in the right kidney region. She was discharged from the hospital on June 21, 1933, and referred to the urological out-patient clinic for further study.

Several weeks later, cystoscopy and pyelography confirmed the diagnosis of a renal tumor. The plain roentgenogram and pyelogram showed an irregular dense calcified shadow in the upper pole of the

kidney in the region corresponding to the periphery of the tumor (Fig 14). The tumor was considered to be inoperable despite the absence of demonstrable metastatic foci in the lungs and long bones, and a course of intensive roentgen irradiation was instituted on July 3, 1933, and carried out at regular intervals over the next three years. In July, 1933, roentgenogram of the lungs and long bones again failed to reveal any metastases. Despite deep roentgen therapy, metastatic foci were demonstrable in the lungs and ribs in August, 1935, and in the cervical vertebrae in August, 1936. The patient became progressively weaker and succumbed in October, 1936.

Case XVII (G U 526), E W, male, 63 years of age, married, salesman, was admitted to the Sinai Hospital on Jan 10, 1938, complaining of increasing weakness, dyspnea, precordial pain, and pain in the right flank for the past eight months. The pain in the right flank was of a severe, gnawing character and persistent. He had lost 18 pounds in weight during this time. There were no urinary difficulties other than slight frequency. His past history was interesting inasmuch as on Jan 25, 1927, his left kidney, which contained two encapsulated tumor masses in the lower pole, had been removed. Each tumor was approximately 5 cm in diameter and histologically showed the characteristic structure of a hypernephroma. The pre-operative diagnosis of left renal neoplasm was based on the history and physical findings, and was confirmed by pyelography. Unfortunately no pyelographic studies of the right kidney were made, although the calcified shadows in the right kidney area were noted but were considered to be gallstones (Fig 15). Following the operation, the patient enjoyed good health until the present illness.

Physical examination was essentially negative except for the abdomen, which contained a large round mass, about the size of a grapefruit, in the right upper quadrant. The mass was firm, tender, but

Neuberger), (4) carbolic acid (Schinchiyo-Uyeno), (5) chromic acid (potassium chromate) (Neuberger), (6) copper sulphate, iodine, and iodoform (Von Kossa), (7) glycerin, pyrogalllic acid, arsenic, and veratrin (Afanassiew), (8) lead acetate (Prevost and Binet), (9) naphthol (Schmidt), (10) oxalic acid and potassium oxalate (Franklen, Neuberger and others), (11) phosphorus (Neuberger), and (12) tuberculin of Koch (Docray). Similar changes have been observed experimentally following the injection of the following chemicals directly into the kidney substance: (1) formalin (Putti), (2) bichloride of mercury (Tartarini-Gallerani), and (3) lysol, phenol (ortho-, meta-, or para-cresol) (Bolognesi).

As a general rule, the calcium infarcts, which develop following the intravenous injection of these various chemicals, appear as fine granulations in the tubules of the cortical zone, occasionally in the medullary area, and rarely in the glomeruli. They may be found in the walls, epithelium, and lumen of the tubules or in the surrounding interstitial tissue. In the lumen of the tubules, they conform to the shape of the lumen and appear black to transparent light and white to reflected light.

III. NON-METASTATIC CALCIFICATION OF THE DYSTROPHIC TYPE

(Calcification Associated with Destructive or Degenerative Lesions of the Kidney, Type III)

(A) Acute or Chronic Infectious Lesions

1. *Pyelonephritis*—Newman was one of the earliest writers to emphasize the occurrence of calcified inflammatory products in the kidney. Baetjer (1907) pointed out that suspicious shadows simulating those of renal calculi may be caused by dense cicatrices of the kidney. In a discussion of the chronic form of hematogenous nephritis of bacterial origin and the interesting sequelae of this condition, W. J. Mayo (1919) mentioned the occasional deposits of calcium carbonate in an area which is usually situated close to or connected with

the capsule and produces a shadow on the roentgenogram closely resembling that of a renal calculus. Albright, Dienes, and Sulkowitch reported two cases of diffuse calcification of the pyramids of both kidneys secondary to a chronic pyelonephritis caused by the *Hæmophilus influenza*, a small gram-negative bacillus with urea-splitting properties. In both cases, sulfanilamide therapy promptly eliminated the organisms from the urine.

2. *Abscess of Kidney*—Mathe presented a roentgenogram showing a calcified area in the lower pole of both kidneys. These shadows represented calcification of a cortical abscess of the subacute or chronic urogenous type resulting from stasis of the urinary tract.

Case I (G. U. 3,000), W. P., male, 30 years of age, married, clerk, was referred by his family physician on Sept. 25, 1925, because of pus in his urine. His chief complaints were a tired feeling and pain in the right lumbar region and right hip. There was no history or symptoms of genito-urinary disease. At this time, physical examination was essentially negative and urinalysis disclosed no abnormal findings. Cystoscopic and pyelographic studies revealed no evidences of disease in the kidney, ureter, or bladder. Despite the absence of any infection, it was felt that we were dealing with an intermittent type of pyelonephritis, and further observation and re-examination were advised. Subsequent study revealed a bilateral staphylococcal pyelonephritis and chronic prostatitis due to the same organism. Treatment directed toward eradication of these infections was instituted with relatively little improvement. The infectious process in the left kidney proved very resistant to all internal medication and instrumental treatment, and the kidney underwent pyonephrotic changes which were confirmed by pyelographic study on Sept. 2, 1926. At this time, no evidence of calculi or calcification were detected on the roentgenogram or pyelogram.

On Nov. 12, 1926, the kidney was removed and the patient made an unevent-

favorable sign. The question as to whether we were dealing with bilateral primary renal neoplasm or with a primary neoplasm in the right kidney, with secondary or metastatic involvement of the left kidney, must remain a matter of conjecture until further histological studies of both tumors are made.

(b) *Other Malignant Tumors (Carcinoma, Sarcoma, Mixed Tumors, Myoma, etc)* — Calcification has also been observed in other types of renal tumors. Keen (1889) reported a case of an "encephaloid" carcinoma of the kidney, with calcified blood vessels, which simulated renal calculi. Kischinsky observed a calcified squamous-cell carcinoma of the kidney with multiple metastases. Louneau (1910) observed a case of calcified renal carcinoma which simulated tuberculosis. Grosghk (1911) described a case of calcified blood clot in the center of a carcinoma of the left kidney, which was mistaken for a renal calculus. In 1930, Federoff observed calcification in a tumor (sarcoma?) of a supernumerary kidney. Crosbie and Pinkerton (1932) reported a case of malignant myoma of the kidney which showed histological evidences of early calcification. Recently Rosenberg reported two cases of adenoma of the adrenal gland associated with a hypernephroma. In each instance the hypernephroma showed areas of calcification.

BIBLIOGRAPHY¹

- ABBOT F C St Thomas Hosp Repts 1894, 22, 261
 ADAMSON, BOYD and CAMERON Quoted by Chown loc cit
 AFANASSIEW Virchow's Arch f Path u path Anat, 1894 98, 460
 AFIPI M A. Am Jour Roentgenol and Rad Ther 1934 31, 208
 AKERBERG E Hygiea 1932 94, 169
 ALBARRAN, J and IMBERT L Les Tumeurs du Rein Masson et Cie, Paris 1905 pp 501-511
 ALBRECHT, P Arch. f klin Chir 1905 77, 1112
 ALBRIGHT, F BAIRD P C COPE O BLOOMBERG E Am Jour Med Sci, 1934 187, 49
 ALBRIGHT, F and BLOOMBERG E Jour Urol 1935, 34, 1
 ALBRIGHT, F DIENES L and SULKOWITZ H W Jour Am Med. Assn Jan 29, 1938 110, 357
 ARENA G Riforma Med. 1926 42, 577
 ARKIN A Surg, Gynec and Obst, 1926 43, 155
 ASAMI, G and DOCK, W Jour Exp Med 1920, 32, 745
 ASHER, G Arch Dis Child, 1936 11, 311
 ASKANAZY, M Beitr z Knochenpathologie Ftschr f Jaffl, Vieweg, Braunschweig 1901
 Idem Beitr z path Anat u z allg Path 1893, 14, 33
 ASK-UPMARK E Acta Med Scandinav 1921 54, 539
 AXHAUSEN G Deutsch Ztschr f Chir 1908 92, 42
 BAETJER F H Am Quarterly Roentgen 1906 1, 17
 BARILLE A Jour de Pharm et de Chem, 1904 19, 71, 196 245 295
 BARIJOU Congres de Claremont, Terrand 1908
 BARNEY, J D Jour Urol 1936 36, 602
 BARNEY J D and MINTZ E R Jour Am Med Assn 1934 103, 741
 BARONI G Arch Ital de Chir 1925 13, 530
 BARR, D P and CHARLES, C M Libman Anniv Vols 1932 1, 155
 BARR, D P, and BULGER H A Am Jour Med Sci, 1930 179, 449
 BARR, D P, BULGER, H A and DIXON H H Jour Am Med Assn 1929 92, 951
 BAUER R Munchen med Wehnschr 1913, 60, 1413
 BAUM E W Virchow's Arch f Path u path Anat 1900 162, 85
 BEER E Jour Path and Bacteriol, 1904 9, 225
 BENDER O Deutsche Ztschr f Chir 1902 63, 370
 BERGSTRAND H Acta Med Scandinav, 1921 54, 539
 Idem Virchow's Arch f Path u path Anat 1923 245, 193
 BERNER D Virchow's Arch f Path u path Anat. 1931 282, 680
 BILLS C E, and WIRECK A M Jour Biol Chem 1930 86, 117
 BIRKELO C C Jour Radiol 1923 4, 63
 BIRSCH HIRSCHFELD F V Beitr z path Anat u allg Path 1898 24, 343
 BLESSIG Arch f path Anat 1859 16, 120
 BLUM V Ztschr f urol Chir, 1933 37, 46
 BOGERT L J and HASTINGS, A B Jour Biol Chem 1931 94, 473
 BOGERT L J and KIRKPATRICK E E Jour Biol Chem 54, 375
 BOLOGNESI Ann des Mal d Org Genito urin 1907 Jour d Urol 1914 6, 693
 BRAASCH W F Jour urol 1930 33, 1
 BRAASCH W F and GRIFFIN M Jour Am Med. Assn. 1936 106, 1343
 BRAASCH W F and OLSEN F A Surg Gynec and Obst 1919 28, 555
 BRAND and HOLTZ Ztschr f physiol Chem 1929, 185, 217
 BRILL N E and LIBMAN E Jour Exp Med 1899 4, 541
 BROWN EUSTERMANN, HARTMAN and ROWNTREE Arch Int Med 1923 32, 425
 BRUGNATELLI E Folia Urologica 1911 6, 54
 BURCHARD A Fortsch a d Geb d Röntgenstrahlen 1913 20, 244
 BUSSE Virchow's Arch f Path u path Anat 1898 15, 346
 BUTLER Proc N Y Path Soc 1924 24, 79
 BUTLER A M WILSON J L and FARBER S Jour Pediatrics April 1936 8, 489
 BYRUM Oklahoma St Med Assn Jour 1931 24, 305
 CAMPBELL M F Jour Urol 1933 39, 677
 CANIGIANI T Röntgenpraxis 1936 8, 561

¹ Part II to follow. The bibliography is here printed to serve the convenience of the reader.

patient, the disease process had been present for 35 years, and in Conybeare's patient 25 years. Dewitt reported a case of clinically healed tuberculosis of 15 years' duration in which he found three calcified areas in the kidney. Scholl observed a case of total calcification of six years' duration in a nine-year-old child.

The types of shadows seen in the roentgenogram in renal tuberculosis have been classified by Braasch and Olsen, Eisendrath, Stevens, and others under three general headings in order of their frequency.

Group I. Scattered small areas in the form of single elongated streaks or multiple punctate areas which are usually confined to one pole of the kidney.

Group II. Single or multiple isolated and circumscribed areas which are of irregular outline and variable density.

Group III. Large irregular shadows of variable density involving a large portion of the entire kidney.

Groups I and III are sufficiently distinct and characteristic to be considered pathognomonic of renal tuberculosis. In the first group, the calcification is a more or less localized process but is not a true indication of the degree of tuberculous infection present. It is well recognized that calcification rarely, if ever, occurs in the early stages of renal tuberculosis and, furthermore, that extensive tuberculous destruction may occur without any demonstrable signs in the plain roentgenogram or pyelogram, due to the fact that the pelvis and calices are not involved and the tuberculous areas have the consistency and density of normal tissue. These areas cast a shadow only when calcium is deposited in the caseated or necrotic areas. The intensity of the shadows may vary in the same or different lesions. In some instances of early calcification, it is extremely difficult to detect the presence of pathologic shadows which may be very dim or scarcely discernible. In other cases the involved areas are clearly delineated.

In Group II, the calcified shadows indi-

cate a more advanced stage of ulcerative renal tuberculosis. These shadows may cause difficulties in differential diagnosis as they are frequently confused with renal calculi. Their multiplicity, irregularity, and location in widely separated points in the parenchyma tend to differentiate these calcified tuberculous shadows from renal calculi. The shadows of tuberculous calcification are not as sharply defined as those of stones, the borders are relatively indistinct and gradually fade off into the surrounding tissue. However, it must be borne in mind that calculi may occur in a tuberculous kidney.

The third group includes the more advanced types of renal tuberculosis, *viz* the symptomatic occluded type and the asymptomatic autonephrectomized kidney. In these cases intravenous pyelography is useless because of the extensive destruction of renal tissue, and a retrograde pyelogram is often impossible because of advanced bladder changes or occlusion of the ureter. Consequently, the diagnosis is made from the plain roentgenogram. The kidney outline is usually smaller due to shrinkage and atrophy and lobulated with a marked thinning of the parenchyma due to the calcified masses. The calcified shadows in the kidney area are usually hemispherical or clover-leaf in outline. These cases are frequently referred to as a "putty" or "cement" kidney in the English literature, as "morteliere" or "kittmiere" by Germans, and as "rien mastic" by the French and Spanish. Calcification of the pelvic and ureteral wall (so-called canal tuberculosis) may be observed in the same cases.

Case II (G U 5,437), J. E., male, 30 years of age, married, clerk, was seen for the first time on Aug. 23, 1934. A left nephrectomy for renal tuberculosis had been performed in March, 1927, at another hospital. The patient was in apparent good health until January, 1931, when he developed urgency, frequency, burning, and dysuria which have persisted to date. Physical examination was essentially negative. Urine showed faint trace of albumin.

- ISRAEL, J, and ISRAEL, W Chirurgie der Niere und der Harnleiter G T Thieme Leipzig, 1925, p 84
- JACKSON, C M Arch Path 1929 7, 1042, 8, 81, 273
- JAFFE H L, BODANSKY, A and BLAIR J E Arch Path, 1931, 11, 207
- JOLY S J Stone and Calculous Disease of the Urinary Organs C V Mosby Co, St Louis, 1931
- JONES, H F Urol and Cutan Rev 1934, 28, 195
- JONES R W and ROBERTS, R E British Jour Radiol 1934 7, 329 391
- JOSEPH E Ztschr f Urol, 1928 22, 798
- KAIRIS Arch f klin Chr 1928, 149, 700
- KATASE Beitr z path Anat u allg Path, 1914 57, 110
- KAY H D Biochem Jour 1926 20, 791
- Idem Physiol Rev 1932 12, 411
- KEEN M R Am Jour Surg 1934, 25, 467
- KEEN W W Maryland Med Jour, 1888-1889, 20, 484
- KELLY, H A, and BURNAM C I Diseases of the Kidneys Ureters and Bladder D Appleton and Co N Y 1915
- KEY E and AKERLUND A Fortschr a d Geb d Röntgenstrahlen 1917, 25, 551
- KEYES E L, JR Urology D Appleton and Co, N Y 1917
- KEYSER L D Arch Surg 1923 6, 525
- Idem Ann Surg, 1923 77, 210
- KIDD J Practitioner 1882 29, 104
- KIRWIN T J Jour Urol 1926 15, 275
- KISCHEVSKY D Centralbl f allg Path 1901 12, 674
- KITT Lehrbuch d Pathol Anat Diagnostik Stuttgart 1895 2, 495
- KLEINMAN H Biochem Ztschr 1928 196, 98, 146 161
- Idem Virchow's Arch f Path u Anat 1928 248, 686
- KLEMENT R Ztschr f physiol Chem 1929 184, 132 1930 194, 140
- KLINKE K Ergebn d Physiol 1928 26, 235
- Idem Biochem Ztschr 1929 213, 177
- KLOTZ O Jour Exp Med 1905 7, 633
- Idem Am Jour Physiol 1905 13, 21
- KNERR E B Am Jour Roentgenol 1918 1, 119
- KOCH M Henke and Lubarsch Handbuch der speziellen path Anat u Histol J Springer 1925 6, 725
- KOEHLER A Internat Cong Med London Roentgen Section August 1913
- KOLL E Fortschr a d Geb d Röntgenstrahlen 1913 20, 298
- KRAFT F Fortschr a d Geb d Röntgenstrahlen 1923-1924 31, 793
- Idem Ztschr f urol Chr 1920 50, 16
- KRAMER B Am Jour Dis Child 1929 38, 662
- KRAMER B and SHEAR M J Jour Biol Chem 1928 79, 121 147
- KRAMER G and HOWLAND J Am Jour Dis Child 1921 22, 105
- KREITMAR H and MOLL T München med Wehnschr 1928 75, 637
- KRETSCHMER H L Surg Gynec and Obst 1930 51, 404
- KRONLEIN and WIS Quoted by Fabricius loc cit
- LANGFELDT Norsk Mag f Lægevidensk 1934 95, 289
- LANGHANS T Deutsche Ztschr f Chir 1885 22, 575
- Idem Virchow's Arch f Path u path Anat 1907 189, 69
- LAQUIERE M Jour de Chir 1925 26, 257
- LATTERI Arch Ital di Urol 1930 6, 113
- LEPEHNE G Med Klin 1930 26, 698
- LERICHE R and POLICARD A La Physiologie normale et pathologique de l'Os Paris 1926
- Idem Surg, Gynec and Obst 1926 46, 308
- LICHTENSTEIN, R Wien klin Wehnschr 1926, 39, 1156
- LILK, C Arch f klin Chr, 1906, 80, 279
- LIGHTWOOD, R Unpublished paper read before British Pediatric Assn June, 1935 quoted by Butler Wilson, and Farber, loc cit
- Idem Arch Dis Child, 1935 10, 205
- LITTEN, M Virchow's Arch f Path u path Anat 1881, 83, 508
- LOHMAN Quoted by Gruber, loc cit
- LOMON M Bull et Mem Soc de Radiol de Paris, June 1913, 5, 247
- LORENZETTI Clinica Chirurgica 1930, 6, 263
- LORRAINE Bull et Mem Soc Anat 1914 16, 183
- LOTSY Fortschr a d Geb d Röntgenstrahlen 1922, 30, 210
- LOUMEAU E Gaz Hebdom d Med d Bordeaux 1910, 31, 398
- LOZZI V Bull e Atti d r Accad Med di Roma, 1931, 57, 396
- LUBARSKY O Henke and Lubarsch, Handbuch der speziellen path Anat u Histol J Springer Berlin 1925, 6, 564
- LUCAS, R C Lancet, 1883 1, 993
- MACCALLUM Quoted by Albright, Baird Cope, and Bloomberg loc cit
- MACCARRISON, L British Med Jour 1927 1, 717
- MACNAUGHTON Am Jour Obst and Gynec 1901 19, 1521
- MARION G Jour d'Urol 1912 1, 655
- MARTLAND M Biochem Jour 1925 19, 117
- MARTLAND, M, and ROBISON R Biochem Jour 1924, 18, 765 1354, 1926 20, 247
- MATHE, C P Jour Am Med Assn 1929, 93, 1862
- Idem Jour Urol 1932 27, 607
- MAXIMOW Anatom Anzeiger 1906 28, 24
- MAYO W J Jour Am Med Assn 1919 73, 1023
- MAZZINI A F Semana Med 1930 37, 1581
- MELICOW M M N Y St Jour Med 1936 36, 728
- MELLY B Orvosi Hetl 1933 77, 1156
- MENDEL, L B Jour Am Med Assn 1932 98, 1981
- MEYER P Beitr z klin Chr 1927 138, 233
- MICHELOZZI L Pathologica 1929 21, 564
- MINAKOWSKI O Arch f exper Path u Pharma kol 1898 41, 375
- MITCHELL A G Am Jour Dis Child 1930 40, 101 345
- MOEHLIG R C MURPHY J M and REYNOLDS L Am Jour Roentgenol, and Rad Ther 1935 34, 465
- MOHR W Röntgenpraxis 1937 9, 616
- MONCHBERG J G München med Wehnschr 1920 67, 365
- MORO N Deutsche Ztschr f Chir 1933 240, 262
- MORRIS H Surgical Diseases of the Kidney and Ureter Cassel and Co London 1905 1, 626 1885 p 504
- MUDD J Quoted by Roberts loc cit
- MURATA M Virchow's Arch f Path u path Anat 1923 245, 448
- MUUS Virchow's Arch f Path u path Anat 1899 145, 408
- MYER P Beitr z klin Chr 1926 138, 233
- NAZARRO A Policlinico 1904 11, 146
- NELKIN L and STEINMETZ Ztschr f klin Med 1926 103, 317
- NEUBERGER S Beitr z path Anat u z allg Path 1889 6, 429
- Idem Arch f exper Path u Pharmac 1890 27, 39
- NEUHOF H Surg Gynec and Obst 1917 24, 383

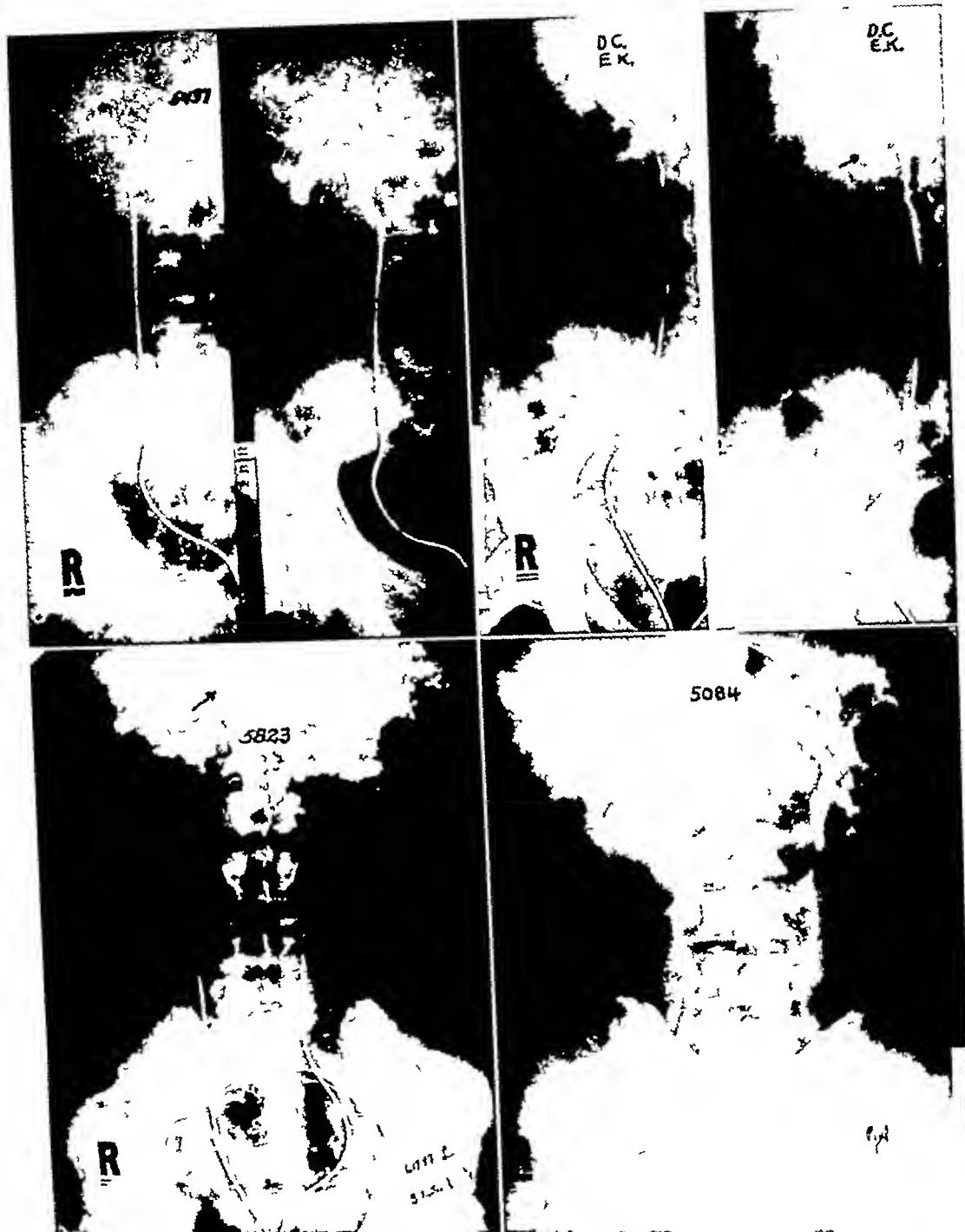


Fig 1 (upper left) Case II In the plain roentgenogram the arrows point to several irregular calcified shadows scattered throughout the parenchyma In the pyelogram these appear to involve the pyramids and are interpreted as evidences of healing in old tuberculous abscesses The moth-eaten appearance of the terminal calices is characteristic of tuberculosis

Fig 2 (upper right) Case III The irregular calcified shadows in the plain roentgenogram are indicated by arrows They appear to extend outward from the tips of the calices in the pyelogram

Fig 3 (lower left) Case IV A bilateral pyelogram showing calcification of the right adrenal gland (indicated by the arrow) the spleen both seminal vesicles and the prostate

Fig 4 (lower right) Case V A bilateral pyelogram showing the irregular fuzzy outline of the lower major calyx characteristic of tuberculosis The calcified shadows appear to be in the parenchyma

- ISRAEL, J. and ISRAEL W. *Chirurgie der Niere und der Harnleiters* G T Thieme Leipzig, 1925, p 84
- JACKSON C M *Arch Path*, 1920, 7, 1042, 8, 81, 273
- JAFFE, H L, BODANSKY, A, and BLAIR, J E *Arch Path*, 1931 11, 207
- JOLI, S J *Stone and Calculous Disease of the Urinary Organs* C V Mosby Co St Louis, 1931
- JONES H F *Urol and Cutan Rev* 1934 28, 198
- JONES, R W and ROBERTS, R E *British Jour Radiol*, 1934, 7, 329 391
- JOSEPH E *Ztschr f Urol* 1928 22, 798
- KAIRIS *Arch f klin Chir* 1928, 149, 700
- KATASE *Beitr z path Anat u allg Path*, 1914, 57, 116
- KAY H D *Biochem Jour*, 1926 20, 791
- Idem *Physiol Rev* 1932 12, 411
- KLEY M R *Am Jour Surg* 1934 25, 467
- KLEY, W W *Maryland Med Jour* 1888-1889, 20, 484
- KELLA, H A, and BURNAM C F *Diseases of the Kidneys, Ureters and Bladder* D Applton and Co N Y 1915
- KEY, E and ABERLUND A *Fortschr a d Geb d Röntgenstrahlen* 1917, 25, 551
- KEYES, E L, JR *Urology* D Applton and Co, N Y 1917
- KEYSER L D *Arch Surg*, 1923, 6, 525
- Idem *Ann Surg*, 1923, 77, 210
- KIDD J *Practitioner* 1882 29, 104
- KIRWIN T J *Jour Urol* 1926 15, 275
- KISCHEVSKY, D *Centralbl f allg Path* 1901 12, 674
- KITT *Lehrbuch d Pathiol Anat Diagnostik* Stuttgart 1895 2, 495
- KLEINMAN H *Biochem Ztschr* 1928 196, 98 146 161
- Idem *Virchow's Arch f Path u Anat* 1928 248, 686
- KLENENT R *Ztschr f physiol Chem* 1929 184, 132, 1930, 194, 140
- KLINAE, K *Ergbn d Physiol* 1928 26, 235
- Idem *Biochem Ztschr* 1929 213, 177
- KLOTZ, O *Jour Exp Med* 1905 7, 833
- Idem *Am Jour Physiol* 1905 13, 21
- KNERR, E B *Am Jour Roentgenol* 1918 1, 110
- KOCH M *Henke and Lubarsch Handbuch der speziellen path Anat u Histol J Springer* 1925 6, 725
- KOEHLE, A *Internat Cong Med London Roentgen Section*, August 1913
- KOLL E *Fortschr a d Geb d Röntgenstrahlen* 1913 20, 298
- KRAFT F *Fortschr a d Geb d Röntgenstrahlen* 1923-1924 31, 793
- Idem *Ztschr f urol Chir* 1920 50, 16
- KRAMER, B *Am Jour Dis Child* 1929 38, 662
- KRAMER B and SHEAR M J *Jour Biol Chem* 1928 79, 121 147
- KRAMER G and HOWLAND J *Am Jour Dis Child* 1921 22, 105
- KREITMAR H and MOLL T *München med Wchnschr* 1928 75, 637
- KRETSCHMER, H L *Surg Gynec and Obst* 1930 51, 404
- KRONLEIN and WIS *Quoted by Fabricius loc cit*
- LANGFELDT *Norsk Mag f Lægevidensk* 1934 95, 289
- LANGHANS T *Deutsche Ztschr f Chir* 1885 22, 575
- Idem *Virchow's Arch f Path u path Anat* 1907, 189, 69
- LAQUIERE M *Jour de Chir* 1925 26, 257
- LATTERI *Arch Ital di Urol* 1930 6, 113
- LEPEHNE G *Med Klin* 1930 26, 698
- LERICHE R and POLICARD A *La Physiologie normale et pathologique de l'Os* Paris 1926
- Idem *Surg, Gynec and Obst*, 1926, 46, 308
- LICHTENSTEIN R *Wien klin Wchnschr*, 1926 39, 1156
- LILK, E *Arch f klin Chir*, 1906, 80, 279
- LIGHTWOOD, R *Unpublished paper read before British Pediatric Assn*, June, 1935, quoted by Butler Wilson and Farber, *loc cit*
- Idem *Arch Dis Child*, 1935 10, 205
- LITTEN, M *Virchow's Arch f Path u path Anat* 1881, 83, 508
- LOHMANN *Quoted by Gruber loc cit*
- LOMON M *Bull et Mém Soc de Radiol de Paris* June, 1913, 5, 247
- LORENZETTI *Clinica Chirurgica* 1930, 6, 263
- LORRAINE *Bull et Mém Soc Anat*, 1914, 16, 183
- LOTSY *Fortschr a d Geb d Röntgenstrahlen* 1922 30, 210
- LOUVEAU, E *Gaz Hebdom d Med d Bordeaux* 1910 31, 398
- Lozzi V *Bull e Atti d r Accad Med di Roma* 1931, 57, 396
- LUBARSCHE O *Henke and Lubarsch Handbuch der Speziellen path Anat u Histol J Springer*, Berlin 1925, 6, 564
- LUCAS, R C *Lancet* 1883, 1, 993
- MACCALLUM *Quoted by Albright Baird Cope, and Bloomberg, loc cit*
- McCARRISON L *British Med Jour* 1927, 1, 717
- MACNAUGHTON *Am Jour Obst and Gynec* 1901, 19, 1521
- MARION, G *Jour d'Urol*, 1912 1, 655
- MARTLAND, M *Biochem Jour* 1925 19, 117
- MARTLAND M and ROBISON R *Biochem Jour* 1924 18, 705 1354, 1926 20, 247
- MATHE, C P *Jour Am Med Assn* 1929 93, 1802
- Idem *Jour Urol* 1932 27, 607
- MAXIMOW *Anatom Anzeiger* 1906 28, 24
- MAYO W J *Jour Am Med Assn*, 1919 73, 1023
- MAZZINI A F *Semana Med* 1930 37, 1581
- MELICOW M M *N Y St Jour Med* 1936 36, 728
- MELLA B *Orvosi Hetl* 1933 77, 1156
- MENDEL L B *Jour Am Med Assn* 1932 98, 1981
- MEYER P *Beitr z klin Chir* 1927 138, 233
- MICHELOZZI L *Pathologica*, 1929 21, 564
- MINKOWSKI O *Arch f exper Path u Pharma kol* 1898 41, 375
- MITCHELL A G *Am Jour Dis Child* 1930 40, 101 345
- MOERLIG, R C MURPHY J M and REYNOLDS L *Am Jour Roentgenol and Rad Ther* 1935 34, 465
- MOHR W *Röntgenpraxis* 1937 9, 616
- MONCHEBERG J G *München med Wchnschr* 1920 67, 365
- MORO N *Deutsche Ztschr f Chir* 1933 240, 262
- MORRIS H *Surgical Diseases of the Kidney and Ureter Cassel and Co London* 1905 1, 626 1885 p 504
- MUDD J *Quoted by Roberts loc cit*
- MURATA M *Virchow's Arch f Path u path Anat* 1923 245, 448
- MUUS *Virchow's Arch f Path u path Anat* 1899 145, 408
- MYER P *Beitr z klin Chir* 1926 138, 233
- NAZARRO A *Polichimico* 1904 11, 146
- NELKIN L and STEINMETZ *Ztschr f klin Med* 1926 103, 317
- NEUBERGER S *Beitr z path Anat u z allg Path* 1889 6, 429
- Idem *Arch f exper Path u Pharmacol* 1890 27, 39
- NEUHOF H *Surg Gynec and Obst* 1917 24, 383

with putty-like calcareous material, no evidences of any cortical medullary renal tissues were found

4 *Bilharziosis*—This is an extremely rare type of renal calcification. Lotsy described a case of bilharzia of the renal pelvis and the ureter which showed a round shadow with a darker border and two parallel linear shadows running downward from the pelvis toward the ureter on the roentgenogram. The shadows were due to calcium deposits originating in calcification of the numerous eggs of the parasite which, in the older cases, occupied all the layers of the wall of the bladder and ureter and, occasionally, the renal pelvis and the immediately surrounding tissues. Calcified demarcations of the bladder and ureters in cases of long standing bilharziosis have also been observed by Harlow and Affi, Diamantis, and Affi.

5 *Perinephritis or Paranephritis*—Inflammatory changes may develop in the renal capsule following an acute or chronic pyelonephritis, perinephritis, or paranephritis. These changes are usually manifested in the form of a marked thickening or fibrosis of the capsule which may undergo hyalinization or impregnation with organic or inorganic salts. Perussia described a case in which partial calcification of the renal capsule was diagnosed as a stone in the kidney. Baetjer and Smart have called attention to the presence of calcium deposits in the scars in cortical areas of kidney following chronic suppurative diseases of the kidney. Mayo and Mathe have emphasized the presence of calcium deposits in cortical abscesses which are situated near or involving the capsule and are a sequel to chronic pyelonephritis.

Calcification of the perinephritic or paranephritic tissue secondary to an acute or chronic inflammatory process is rarely observed. However, Mathe, Wesson, O'Connor, and others have pointed out that distinctly abnormal shadows in the kidney region may be produced in the roentgenogram by inflammatory processes and are due to sclerosis or fibrosis of these

tissues and their effect upon the kidney outline. Koll observed such shadows in cases of paranephritic abscess and stressed their diagnostic significance together with a careful history. Rosving has described four cases of sclerosing fibrous perinephritis in patients with uric acid diathesis. These capsular changes as a rule do not produce a shadow on the roentgenogram, although Illyes observed one case in his series of three which showed three irregular shadows in the kidney region.

(B) *Obstructive or Degenerative Lesions*

1 *Hydronephrosis*—The presence of calcium deposits in hydronephrosis and pyonephrosis is rarely encountered. The earliest reference to this phenomenon was made by Rayer, in 1843, who described a specimen sent to him by Dr. Elliotson, of England, in 1834, for examination. The specimen was an atrophied kidney containing two shell-like formations formed by the dilated pelvis and the fibrous capsule. Rayer also cited a case of Jacques Sachs who found both kidneys transformed into a mass the consistency of alabaster in a female who had suffered from renal colic for several years. The description of the autopsy findings is very suggestive of a calcified pyonephrosis.

2 *Pyonephrosis*—In his discussion of pyonephrosis, Roberts stated that the pus is gradually inspissated and impregnated with the carbonates and phosphates of lime and magnesia until the kidney is converted into a putty- or chalk-like material which fills up the compartments of the sacculated kidney. He also noted that occasionally the fibrous septa which separate the compartments are extensively calcified. Dickinson stated that the kidney may be practically destroyed by pyelitis and the products shut up in the pelvis until at last nothing remains but an innocuous, though useless, cyst containing a mass of chalky or mortar-like substance. He described a specimen in the museum of St. Bartholomew's Hospital obtained from a female, 62 years of age, and which was obviously a case of calcified hydrone-

LOGY

- WESSON, M B *Ann Surg*, 1923, 83, 246
Idem *Jour Urol* 1930, 24, 595
WESSON M B and FULMER, C C *Am. Jour*
Roentgenol and Rad Ther 1935, 33, 176
WHEELER, W *British Med Jour*, 1930, 1, 1134
WILMS *Des Mischgeschwulste*, 1, 11 Leipzig,
1899-1902
WINSBURY WHITE, H P W *British Jour Urol*
1932, 4, 56
Idem *Proc Roy Soc Med*, 1932 25, 1681
YOUNG, H H and WATERS, C A *Urological*
Roentgenology *Annals of Roentgenology*, Vol VII
Edited by J T Case P B Hoeber Inc, N Y
Second ed pp 263, 264
ZEMAN FRIEDMAN and LUCKETT *Proc New York*
Path Soc, 1924, 24, 41
-

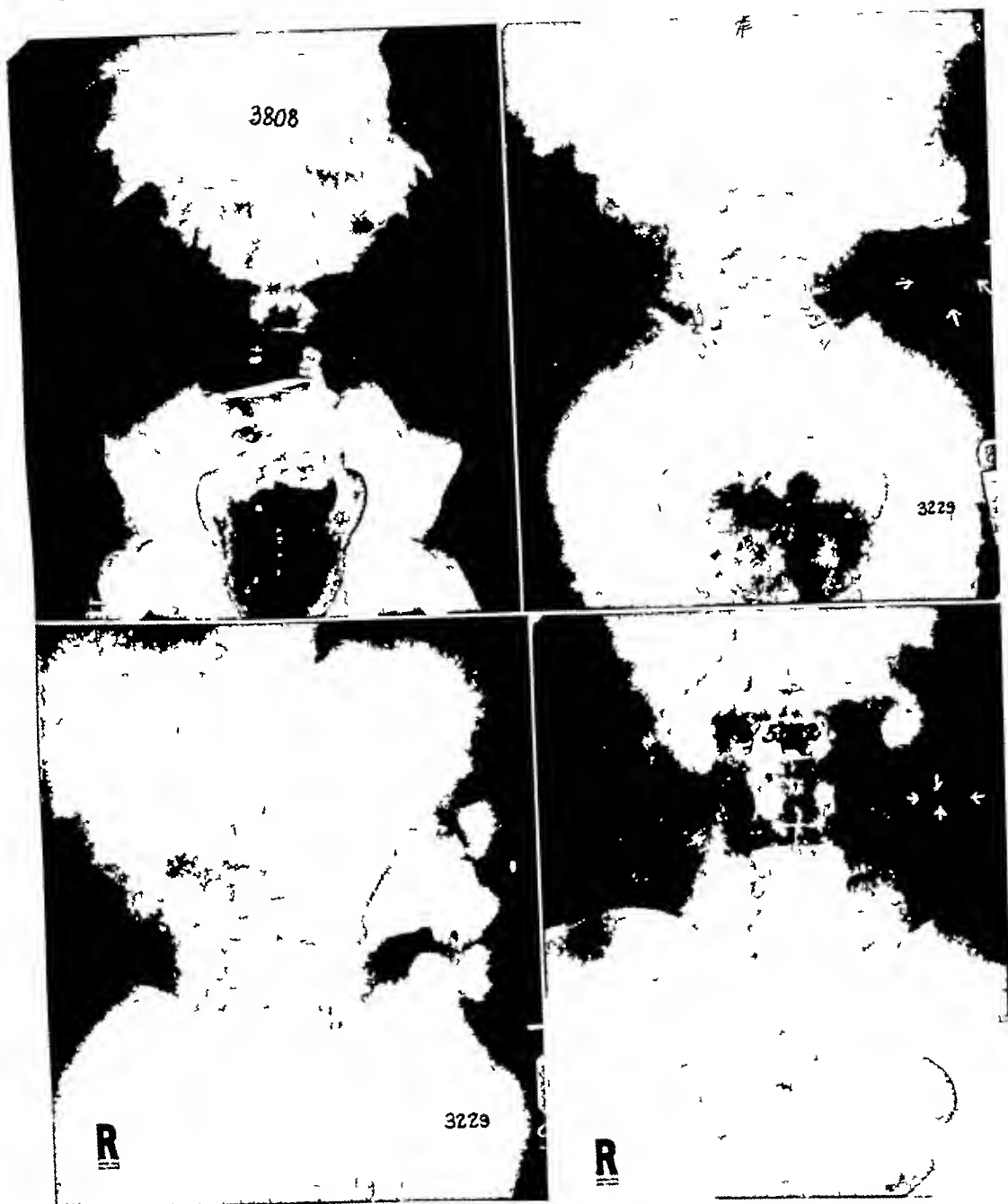


Fig 5 (upper left) Case VI A plain roentgenogram showing an irregular large calcified shadow in the right kidney area simulating a bunch of grapes and characteristic of the occluded calcified type of renal tuberculosis

Fig 6 (upper right) Case VII A plain roentgenogram showing a large calcified shadow in the region of the pelvis and several irregular calcified areas of lesser density in the lower pole of the kidney (arrows) These shadows were interpreted by some observers as calculi but their blotchy appearance irregular outline and decreased density are more characteristic of calcium deposits in the walls of abscess cavities

Fig 7 (lower left) Case VIII A pyelogram showing a large multilocular pyonephrotic kidney On comparing this film with the previous one (Fig 6) it is apparent that the large dense shadow was confined to the pelvis and middle calyx whereas the irregular shadows of lesser density corresponded to the lower major calyx The operative specimen disclosed calcareous deposits lining the abscess cavities but no calculi

Fig 8 (lower right) Case VIII Plain roentgenogram showing a large calculus occupying the pelvis and upper and middle calyces The arrows point to several small irregular shadows of lesser density which are present in the cortical area of the lower pole

- VON KOSSA J Beitr z path Anat u z allg Path , 1901, 29, 163
VON LICHTENBERG, A , and DIETLEN H Mit a d Grenzgeb d Med u Chir , 1911 23, 739
WALSH G and NORTON, E M Southern Med Jour , 1934 27, 224
WARTHIN A S Am Quarterly Roentgen , 1907, 1, 37
WEBER, F P British Jour Child Dis , 1931, 28, 136
WEIL Ann Surg 1907, 46, 418
WEISS E Jour Am Med Assn , 1932 79, 1097
WELLS, H G Arch Int Med , 1911, 7, 721, 1915, 15, 574
Idem Chemical Pathology W B Saunders Co Philadelphia 1925 15th ed , pp 486-504
WELLS, HOLMES and HENRY Jour Med Research 1911 25, 373

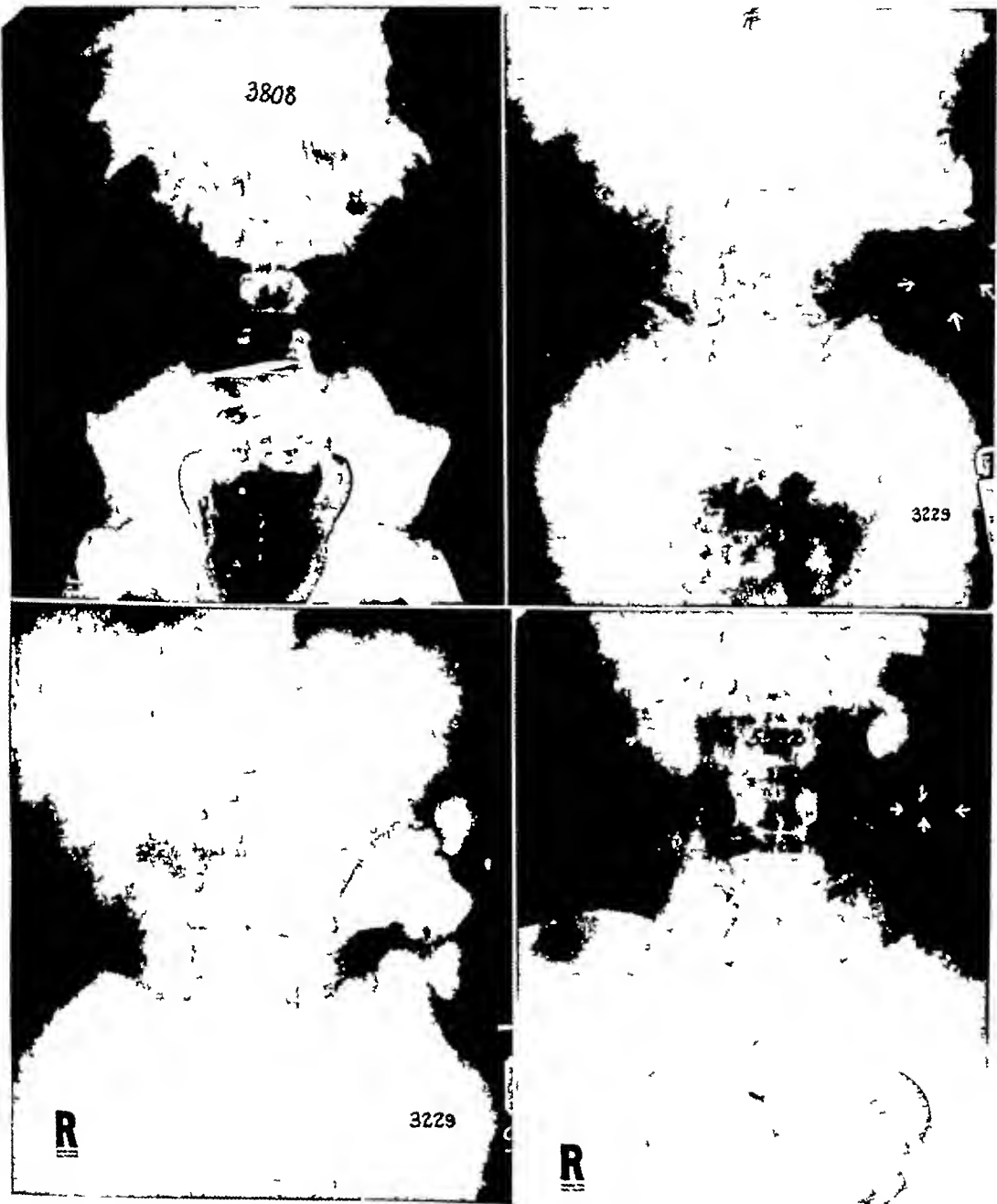


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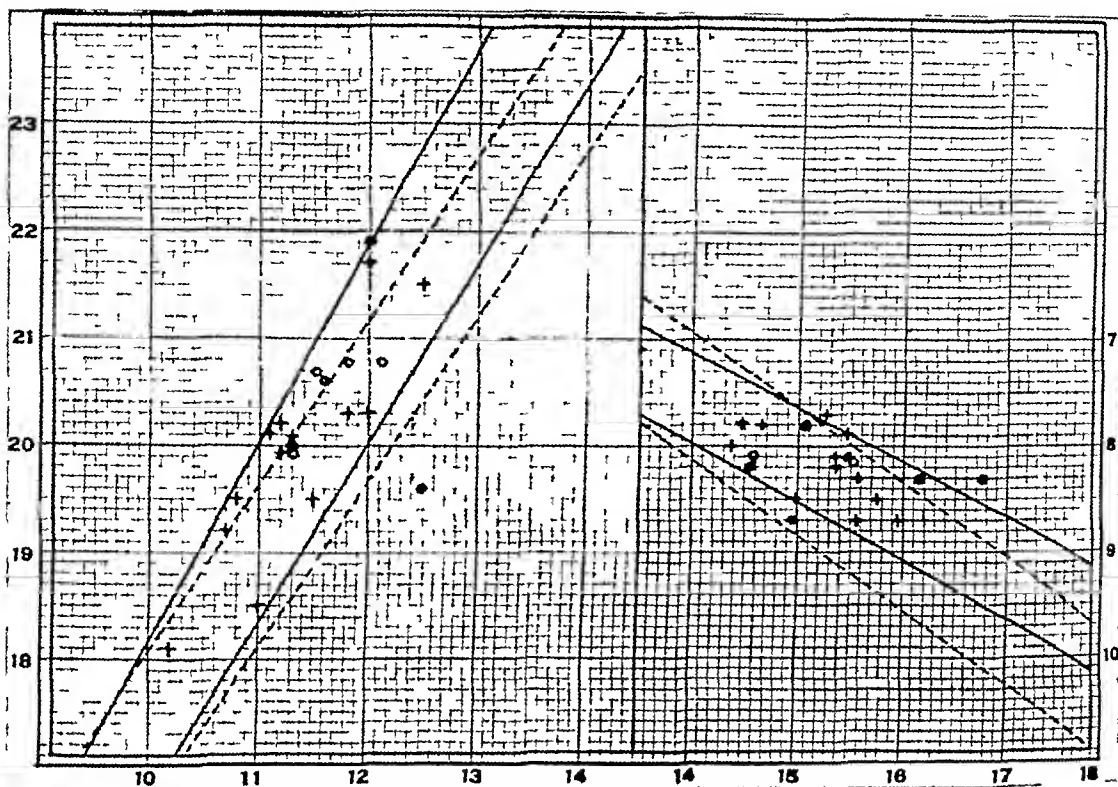


Fig 2 Distribution of pineals in 21 cases of tumors of posterior fossa comparing graphic method (broken lines) with the proportional method (solid lines) Symbols O = cerebellar lobes + = petrous pyramid ● = fourth ventricle

serving for a direct reading of the pineal position by holding the guide against the skull film. The differences in the two methods have been described in some detail in the communication mentioned above. In the normal series, the position of the pineal was found to be interpreted correctly in approximately 84 per cent of these cases by the graphic method and in 92 per cent by the proportional method for measurements relating to the anteroposterior diameter and 89 per cent and 93 per cent for measurements relating to the vertical diameter.

To complete this study, the records of all verified cases² of brain tumor were reviewed and 147 cases were found suitable for analysis, *i.e.*, cases in which the pineal

was calcified sufficiently to enable one to identify its position with certainty, and the brain tumor was verified either by operation or autopsy. All tumor unverified cases or tumor suspects were eliminated from the series.

For analysis the series was first divided according to the location of the tumor within the brain. Tumors of the frontal or parasagittal region (anterior portion) most frequently of all cerebral lobe tumors produced a pineal shift which could be detected by measurement of the lateral film (Fig 1). Of 37 cases of frontal tumors, the pineal in 17 cases was found in normal position when the graphic method was employed and in only nine when the proportional method was used. The most common direction of displacement was posterior. Displacement downward without a simultaneous backward shift was distinctly uncommon, while a combination of two displacements was very common,

² The writer is indebted to Dr W P Van Wagenen, of the Neuro-surgical Division, who generously extended the use of his records, from which was selected a list of all verified cases of brain tumor up to the year 1936. The use of those records greatly facilitated the classification and verification of this series of brain tumors.



Fig 9 (left) Case IX. In the plain roentgenogram ('B') the arrows point to four irregular calcified shadows scattered through the upper part of the right kidney. In the pyelogram ('A') the dye fills several large abscess cavities and obscures the calcified shadows. At operation the abscess cavities in the upper pole of the kidney were found to be lined with a calcareous material which imparted a gritty sensation to the exploring finger; no calculi were found.

Fig 10 (right) Case X. A plain roentgenogram with catheter in right ureter. In the left kidney area, the arrow indicates a large calculus beneath which are seen several smaller calcified shadows in the parenchyma. At operation a large stone was found in the pelvis and several healed calcified abscesses. The shadow in the right kidney is a calculus which subsequently passed into the ureter and was removed by operation.

the pelvis and the small shadows to be within the parenchyma (Fig 10). On Aug 4, 1925, a left pyelolithotomy was performed, at which time several small calcified abscesses were noted in the lower pole of the kidney.

On July 30, 1926, the patient was found to have a large calculus in the right ureter with an infected hydronephrosis on the right. She received several treatments and passed the stone in the right ureter. On March 8, 1929, cystoscopy and pyelography revealed a non-functioning pyonephrotic right kidney with several irregular calcified shadows in the parenchyma of the kidney. On March 12, 1929, the left kidney was removed and showed extensive destruction of the pelvis, calices, and parenchyma. Many large abscesses were scattered throughout the kidney, several

of them containing fine calcareous particles. Histological study showed extensive, acute and chronic pyelonephritis and pyonephrosis.

Case XI (G U 2,927), J L C, 39 years of age, male, married, confectioner, was referred for examination on July 7, 1925, with a complaint of symptomless hematuria. Voided specimen of urine showed an occasional pus cell and red blood cell.

Cystoscopy and pyelography were performed on July 9, 1925. Plain roentgenogram revealed an irregular calcified shadow in the lower pole of the left kidney. The stereoscopic pyelograms showed the shadow in question to be situated in a pyramid immediately adjacent to the lower major calyx. A tentative diagnosis of renal calculus or calcification of the tuberculous abscess was made. Bacteriological study

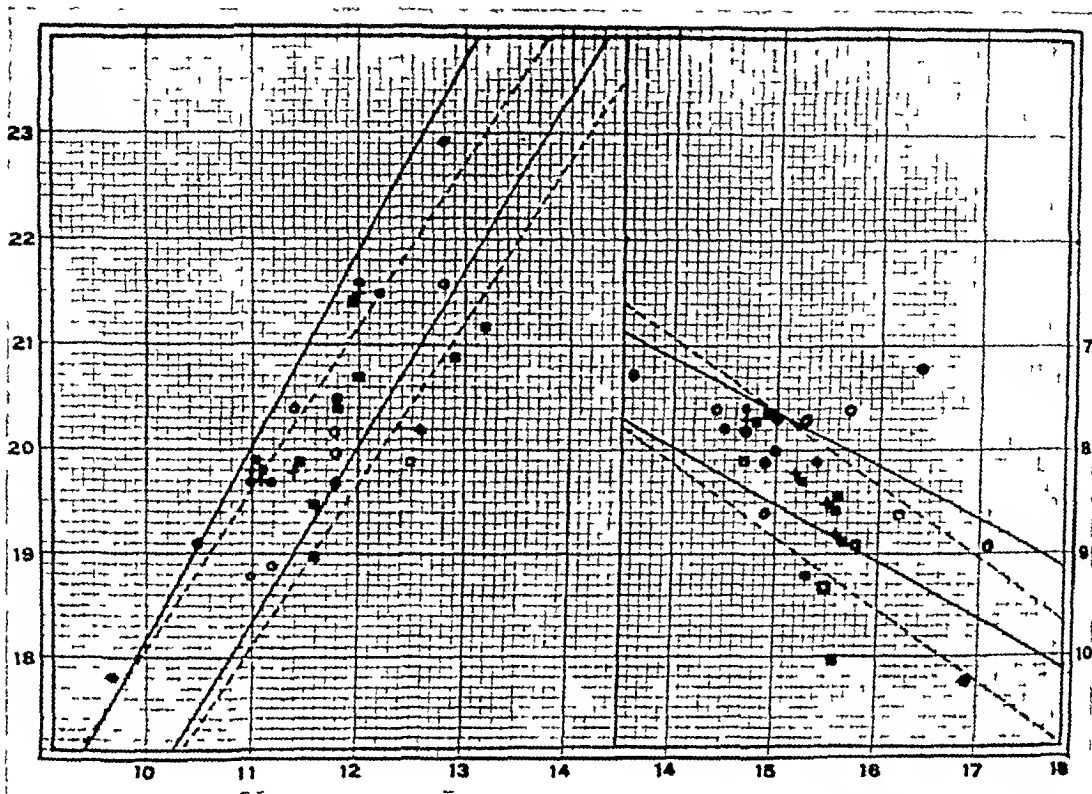


Fig 3 Distribution of pineals in 31 cases of midline tumors of the brain comparing graphic method (broken lines) with the proportional method (solid lines) Symbols ○ = pituitary ● = suprasellar, + = aneurysm of circle of Willis, □ = pineal, ■ = third ventricle

plane of the skull is usually absent, because of the midline location of the main mass of the tumor

Tumors arising within the pineal would not at first glance appear to be capable of displacing the parent organ. However, because of its strategic position at the mouth of the aqueduct of Sylvius and its proneness to produce a dilatation of the third ventricle, secondary to blockage at this level, a crowding backward of the pineal may result. This occurred in two of our cases.

Fluid at the surface convexities of the brain does not commonly produce any recognizable shift of the pineal on the lateral film, but the anteroposterior film becomes important because not infrequently the pineal may be found to the right or left of the midsagittal plane. Tumors of the choroidal plexus and aneurysms of the arteries at the circle of Willis

do not reach a physical size, as a rule, to permit identifying a pineal shift. On the other hand, a midline mass or tumor such as a cyst of the septum pellucidum may displace the pineal both downward and backward. In the few cases of our series of these miscellaneous types, the findings by the graphic and proportional methods were practically identical.

Dividing our tumors according to cell types of origin, of the gliomas (59 cases) 44 per cent were found displaced by the graphic method and 58 per cent by the proportional method by an analysis of the lateral films. On the anteroposterior films of these cases the pineal could be identified in approximately one-half of the cases. A lateral shift of the pineal was a very common finding, being noted in 20 out of the 30 cases. An analysis of the 10 cases showing no shift, the location of the tumor was as follows: two pineal, two



Fig 11 Case XII Plain roentgenogram showing a large multilocular calcified cyst of the right kidney

cum salts and uric acid in the tubules situated between the cysts Domrich (1934) reported a case of calcified cysts diagnosed by roentgenographic examination Small deposits of calcium were found in the walls of several smaller cysts located near the renal pelvis The calcification was attributed to degenerative changes of organized blood clots within the cysts

Case XIII (G U 1,868), C P L, male, 45 years of age, married, merchant, was admitted to Sinai Hospital on Feb 3, 1936, with the complaint of pain in the left upper quadrant and progressive weakness He did not complain of any urinary symptoms On examination of the abdomen, a large irregular mass was found in the left quadrant and a smaller mass in the right upper quadrant The urine, which had a specific gravity of 1 008, gave a positive test for albumin and showed an occasional pus cell

Cystoscopy and pyelographic study revealed the typical changes of bilateral

longer skulls, the pineal lay in front of the normal zone by the graphic method

Adenomas are restricted to the pituitary

the pineal in the lateral film were normal but the anteroposterior film showed a shift of the pineal from the midsagittal plane

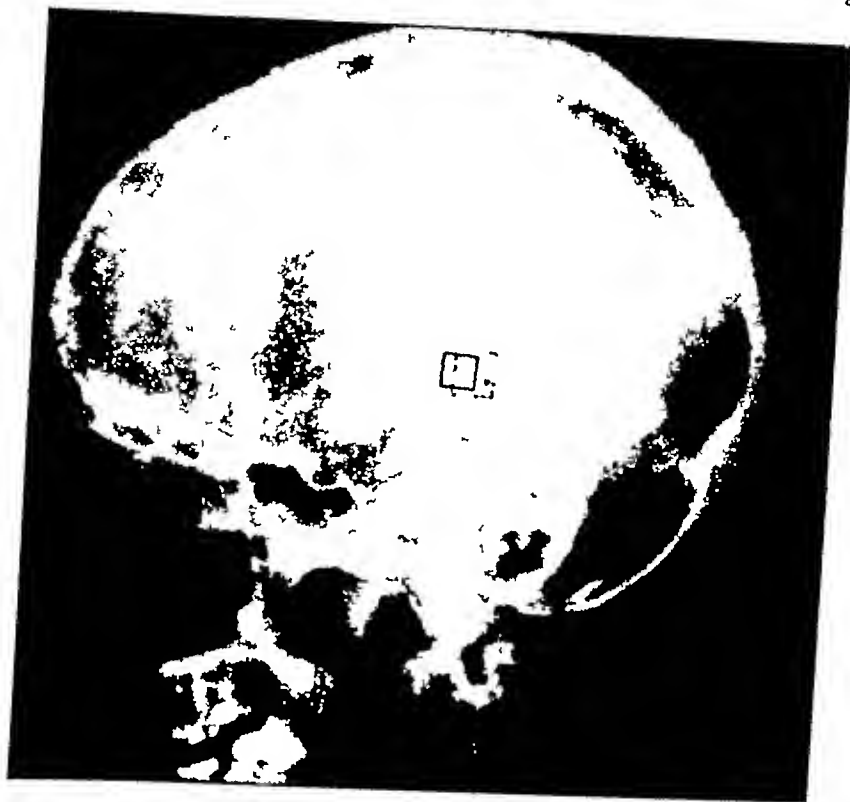


Fig 5 Right temporal glioma with clinical evidence of a left hemiparesis. The pineal does not appear displaced by the graphic method of Vastine and Kinney (broken lines) but appears displaced posteriorly by the proportional method

region. These tumors located at the sella have already been discussed. While there is an unexpectedly large number of pineals lying outside the normal zone, changes in head shape occurring in acromegaly account for many of these findings. Cranio-pharyngiomas usually occur at an age period during which the pineal remains uncalcified, and we have very little information concerning pineal displacement.

Metastatic tumors and tumors growing into the brain structures by direct extension may produce pineal shifts detectable on either the anteroposterior or lateral films. Metastatic tumors are commonly smaller in size than primary brain tumors, death supervening before massive growth results. In some cases of metastatic tumors including abscesses, the measurements of

Tumors of malignant origin arising within the orbit and growing by direct extension did not displace the pineal, but a carcinoma arising within the sphenoid did displace the pineal backward. A granuloma of the right frontal region behaved in much the same manner as a glioma, displacing the pineal backward and to the left of the midline. An osteoma arising within the frontal sinus produced sufficient bulk within the cranium to displace the pineal backward. The graphic and proportional methods gave similar results in this group of tumors, but in two of the longer skulls false results were obtained by the graphic method, forward displacement of the pineal being indicated with growths occurring within the frontal region.

Surface fluid at the convexities of the

the kidney, with the tremendous cyst closely adherent to its posterior border, was removed. Death occurred twenty-four hours after operation.

(b) *Echinococcus Cyst*—Retrogressive changes predisposing to the deposition of calcium salts may occur in other cystic diseases of the kidney. In the earlier textbooks of Rayer, Roberts, and Dickinson, mention is made of the occurrence of calcification in the walls of acephalocysts, i. e., hydatid cysts. In the recent literature there are numerous reports of hydatid cysts, many of which showed calcification. Those interested in this phase are referred to the excellent contributions of Craig and Lee-Brown, Racic, Blum, Koch, Young and Waters, and others.

(c) *Perirenal or Peripelvic Cysts*—Among the rare cystic diseases of kidney and surrounding tissues in which calcification has also been observed are peripelvic cysts, perirenal cysts, and multilocular cysts of the kidney. Israel and Israel (1925) reported an unusual case of nephrolithiasis accompanied by two calcified peripelvic cysts, the size of a plum and cherry, respectively. Colston has described calcification in the walls of perirenal cysts following injuries to the kidney. Wesson (1930) reported a case of multilocular cyst of the lower pole of the left kidney with calcareous degeneration of the walls of the cysts. Winsbury-White (1932) reported a case of stone in the ureter, accompanied by shadow-casting nodules of degeneration in the corresponding atrophied kidney, in a female 29 years of age. He considered the calcified nodule to be the result of degenerative changes in a cyst, a finding which was further substantiated by the presence of a thick hyaline capsule.

(d) *Polycystic Diseases*—A careful search of the literature has revealed an occasional report of calcification of a congenital polycystic kidney. Gruber (1925) stated that calcification may occur in the walls of the cysts in this condition, and cited the observations of Douilland (1827) and Lohman (1853) on the deposition of cal-

position of the pineal was not found to be helpful in localizing and identifying the lesion. The proportional method accomplished two things, it reduced the number of pineals found in the normal zone (Fig 4), and eliminated the error in those cases showing forward displacement. The number showing significant displacement was thus raised to two-thirds of the cases.

In temporal and parietal tumors, displacement of the pineal was much less frequently noted in the lateral film and invariably noted in the anteroposterior film. The most common direction of displacement was similar to that noted in frontal tumors, either backward or downward (Figs 5 and 6). Dyke noted the displacements of these types in seven out of 24 temporal tumors. There were two cases in which forward displacement was indicated. Vastine and Kinney noted backward displacement in six out of 15 cases, while in our series by their method, 10 out of 29 cases with temporal tumor were noted either displaced backward or downward.

Displacements are relatively infrequently observed on the lateral film in tumors of the posterior fossa, the floor of the middle fossa, and third ventricle tumors, regardless of the method employed. Localizing information is less often obtained, not only because the measurements fall within normal limits frequently but also because many gliomas occur within the cerebellum at an age period when calcification is not present. The diagnosis in these cases of necessity must rest on other information.

Lateralizing information can be reliably determined only by actual measurement of the anteroposterior and postero-anterior films. Stereoscopic impressions obtained from lateral films are unreliable even if the observer possesses excellent stereoscopic vision. In this series, a lateral shift was often observed in tumors or fluid of the temporal or parietal regions, less often in frontal tumors (over one-half of the cases), and very rarely in sellar or cerebellar tumors. Vastine and Kinney did not determine the relative percentages

in this manner but stated that in 23 verified cases of lateral displacement, four were in the frontal lobe, nine in the temporal, six in the parietal lobe, while two showed intracranial hemorrhage. Dyke similarly did not give information concerning the number of pineals identified at midsagittal plane but stated that in 23 cases of gliomas and meningiomas in which there was evidence of lateral displacement, two were found in the frontal, eleven in the temporal, three in the parietal, five in the occipital regions, and one was located subtentorially.

Davis has stated that, in his experience, the Vastine and Kinney method has not aided him in localizing masses within the cerebral lobes. A shift to the right or left of the midline helped in the lateralization of a mass above the tentorium but still failed to identify the lobe involved. This has been the common experience of most workers in this field. In this series, this was true to a large extent. However, certain general rules may prove helpful if the shifts in all the three planes of space are considered.¹

- 1 The absence of a lateral shift, determined by actual measurement of the anteroposterior or postero-anterior film, combined with a shift backward or downward, is strong evidence in favor of a frontal tumor.

- 2 The presence of a lateral shift, combined with normal position in respect to the other two planes of space, is strong evidence in favor of a temporal or parietal tumor or a unilateral collection of fluid of these regions.

- 3 The absence of a lateral shift practically rules out a space-occupying mass in the temporal lobe and renders a parietal tumor highly unlikely.

- 4 The absence of any shift in the three planes of space in the presence of a brain tumor indicates usually a subtentorial mass or a basilar midline mass above the tentorium.

- 5 The presence of a lateral shift combined with marked displacement backward

¹ The assumption is made in drawing up these aids in localization that a space-occupying mass is present.

varying in size from a millet seed to a pea, in several portions of the tumor near the surface. Lorraine (1915) reported a case of calcification of a hypernephroma in the upper pole of the right kidney in a 20-year-old male. The calcification was present in the form of three indurated calcified planes in the lower portion of the tumor near the adjacent tissue.

Arkin reported the first case of calcification in a hypernephroma in which an accurate diagnosis was made by roentgenographic and fluoroscopic study and confirmed by operation. In 1921, one of us (A. E. G.) diagnosed a case of calcification and ossification in a hypernephroma by roentgenographic studies. This case was not reported at that time but is included in the present series of cases.

Following this report, cases of calcification in hypernephroma were reported with greater frequency as evidenced by the reports of Braasch, Kretschmer, Keen, Lepehne, Ray, Ravich and Turkeltaub. Braasch and Griffin found roentgenographic evidence of calcification in seven cases. In a personal communication to Keen, Braasch stated that he has observed at least 15 or 20 cases of hypernephroma with roentgenographic evidence of calcification. Arkin and Braasch have emphasized the importance of differentiating these shadows from those caused by renal calculi and tuberculosis. Renal calculi and tuberculosis can usually be excluded by the absence of any clinical, cystoscopic, or urographic data characteristic of these conditions. Braasch suggested that the roentgenographic diagnosis of neoplasms can be inferred by the presence of coincident areas of calcification and unipolar irregularity of the renal outline.

Hypernephromas containing both calcified and osseous tissues have been reported by Pocharissky, Gierke and Frankel, Brugnattelli, Baroni, Arkin and Moro. Calcification of a pseudo-cyst with a hypernephroma has been described by Lepehne. A similar case with osseous changes was reported by Fabricius. Kraft observed a degenerated cystic and calci-

fied hypernephroma in a woman aged 46 years.

Keen reported an unusual case of right renal tuberculosis and left calcified hypernephroma in a 63-year-old man. A diagnosis of left renal tuberculosis was made by an urologist because of the presence of large calcareous deposits in the left renal region. A roentgenogram taken five years later showed no evidence of the calcareous deposits noted previously. At autopsy two years later, the left kidney, previously diagnosed as tuberculous, was the seat of an extensive hypernephroma containing calcium deposits. Smears taken from the tumor mass were negative for tubercle bacilli. The right kidney was tuberculous and contained a metastatic hypernephromatous nodule in the pelvis.

The pathogenesis of calcification in hypernephroma may be readily explained on the basis that this tumor may be present for many years before giving rise to symptoms, and during this long course degenerative and retrogressive changes may occur within the tumor which eventually result in calcification or even osseous metaplasia. These degenerative changes, namely, necrosis, hemorrhage, cystic degeneration, are usually present to some degree in every hypernephroma, but the extent of these changes appears to vary with the size and rate of growth of the tumor.

In the alveolar or papillary type of hypernephroma containing a scant amount of connective tissue, a large pseudo-cyst may develop as a result of necrosis and cystic degeneration. In the solid type which is composed of densely packed nests of cells separated by connective tissue septa or surrounded by capillaries or blood sinusoids, one may detect areas of fresh hemorrhage in the midst of hypernephroma cells, also large and small cysts lined with organized blood clots or blood pigment. As a result of these pressure and vascular changes, the microbotic process involves the tumor mass and its capsule and secondary metaplastic changes, namely, hyalinization, calcification, and,

A STUDY OF TISSUE DOSAGE AND RADIATION EFFECT IN CASES OF OPERABLE CANCER OF THE BREAST TREATED BY A COMBINATION OF PRE OPERATIVE IRRADIATION AND RADICAL MASTECTOMY¹

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Memorial Hospital, New York City

FOR a number of years, various combinations of surgical and radiological methods have been widely used in the treatment of operable breast cancer. Chief of these has been the so-called post-operative prophylactic irradiation after radical mastectomy. During the years 1933-1937, pre-operative irradiation has been employed routinely in operable cases of breast cancer at the Memorial Hospital. This combination of heavy external irradiation with subsequent radical surgery in the operable cases has not been used long enough to warrant evaluation of five-year end-results. It has been demonstrated, however, that this method of therapy results in certain problems of increased morbidity, greater technical operative difficulties, and in a larger percentage of post-operative complications. Some of these clinical problems are reported in detail by one of us (1) in a preliminary report and the subject will not be further discussed in this connection. It is hoped that in time the end-results will show sufficient improvement over those formerly obtained by surgery alone, or surgery and post-operative irradiation, to justify the increased expense to the patient, the greater incidence of complications, and the greater burden on the surgeon and radiologist.

Four years ago, soon after the beginning of this work, it became evident that there was a wide variation in the radiation response of breast tumors of apparently the same clinical type. At operation, it was noted in a few cases that although the tumor had completely disappeared clinically, fully viable cancer cells were identified microscopically in the region of the former tumor, especially in the axillary tissues. In other cases, either no cancer

cells could be found, or those cells which were found showed varying degrees of radiation damage such as atrophy, cell hydrops, and sclerosis. These changes were more commonly seen in the primary breast tumor than in the axillary nodes. The studies in this report will cover only a consideration of the breast tissues, and *not* the axillary contents. Cases showing complete microscopic disappearance of the breast tumor showed abnormal tissue changes, which are interpreted by the pathologist as evidence of the pre-existing cancer. Some cases showed residual gross tumor but the cells showed some of the radiation changes above mentioned.

These observations made in the Pathological Laboratory by Dr Stewart were of sufficient interest to warrant establishing a scale of radiation effect as follows (2)

- "R E B — indicates the radiation effect in the breast tumor
- "R E N — indicates the radiation effect in the axillary nodes
- "R E B 0—signifies that irradiation destruction is most incomplete and has been minimal. It may signify that there was a complete destruction in one area with persistence of viable disease in another area
- "R E B 1—signifies the minimum effects of irradiation, such as atrophy, cell hydrops, and slight sclerosis
- "R E B 2—signifies a more marked condition, but similar to R E B 1
- "R E B 3—signifies that the process of tumor tissue destruction has been extremely marked, and that there is a question whether the tumor cells are viable. It will remain for the element of time to prove whether this R E B 3 group is capable of regeneration or metastasis. Dr Ewing is of the impression that the cases falling into this group may eventually be completely cured and incapable of recurrence. We are taking the position, at least for

¹ Presented before the Fifth International Congress of Radiology, Chicago September 13-17 1937

occasionally, ossification, ensue. The calcium deposits are usually irregular in consistency and confined to one or two areas. In rare instances of long-standing tumors, the calcification may be scattered throughout the entire tumor.

Braasch is of the opinion that calcification is a favorable sign inasmuch as, of the seven patients with calcification in hypernephroma observed by him, all but one lived more than three years and four were alive at the end of five years. One of the authors' patients lived 11 years after operation. Ray interpreted the calcification in a case of hypernephroma as evidence of spontaneous regression. Rohdenburg recently collected 302 cases of so-called spontaneous recession of malignant tumors, several of which were hypernephroma, and stated that necrosis with calcification is the most common type of degeneration associated with recession of malignant tumors.

Case XIV (G U 75), M R, male, 56 years of age, married, tailor, was admitted to the Sinai Hospital on Nov 14, 1921, with a complaint of pain in the left upper quadrant. There were no urinary symptoms other than a slight frequency. On examination, a round firm mass was found in the left upper quadrant, it was not tender and moved with respiration. The urine was negative. The plain roentgenogram and pyelogram showed an irregular crescentic calcified shadow in the lower pole of the kidney which did not resemble a calculus. In the pyelogram, the calcified shadow appeared to be in the periphery of a tumor situated in the lower pole of the left kidney (Fig 12). A pre-operative diagnosis of calcification of hypernephroma was made.

On Nov 18, 1921, a left nephrectomy was performed, convalescence was uneventful and the patient was discharged on Dec 8, 1921. The operative specimen showed a large tumor, of firm consistency

and yellowish-orange in color, which had occupied the lower pole of the kidney. On cross-section several areas of hemorrhage and cystic degeneration were observed. A stony hard, whitish plaque which could not be cut with a knife and required the use of a saw, was encountered at the periphery of the tumor. Microscopic studies revealed typical hypernephromatous changes. The stony hard area was decalcified and showed the characteristic histological evidences of calcification and ossification.

The post-operative course of this patient was extremely interesting and we were fortunate that he remained under our observation until his death. He continued to enjoy good health until May 9, 1928 (approximately seven years after operation), when he was found to have a nodular mass (3 × 2 cm) at the tenth costochondral junction on the right side and a slightly smaller nodule about the size of a pecan in the left parotid region. The former nodule was removed and showed characteristic histological structure of a hypernephroma. On June 11, 1928, he developed metastasis in his right orbit, causing a marked exophthalmos with loss of vision in that eye. A roentgenogram of the chest, taken on July 11, 1928, revealed metastases to his lungs for the first time. He died on Feb 9, 1929, of progressive cachexia.

Case XV (G U 3,927), A M, male, 52 years of age, married, clerk, was first seen by us on Oct 12, 1928, complaining of pain in the right renal region of one month's duration. His family and past histories were negative. About one month before, he developed an attack of dull pain in the right lumbar region, radiating to the right groin, which lasted about nine hours and was unaccompanied by urinary symptoms. Two weeks before, he had a similar attack of pain which lasted only

Fig 15 (lower right). Case XXII. Unilateral pyelogram showing the filling defect (B) produced by a tumor in the lower pole of left kidney. No dye was injected into the right kidney. The calcified shadows in the region of the right kidney, indicated by arrows (A) were originally considered to be gallstones. This film was taken on Jan 18, 1927.

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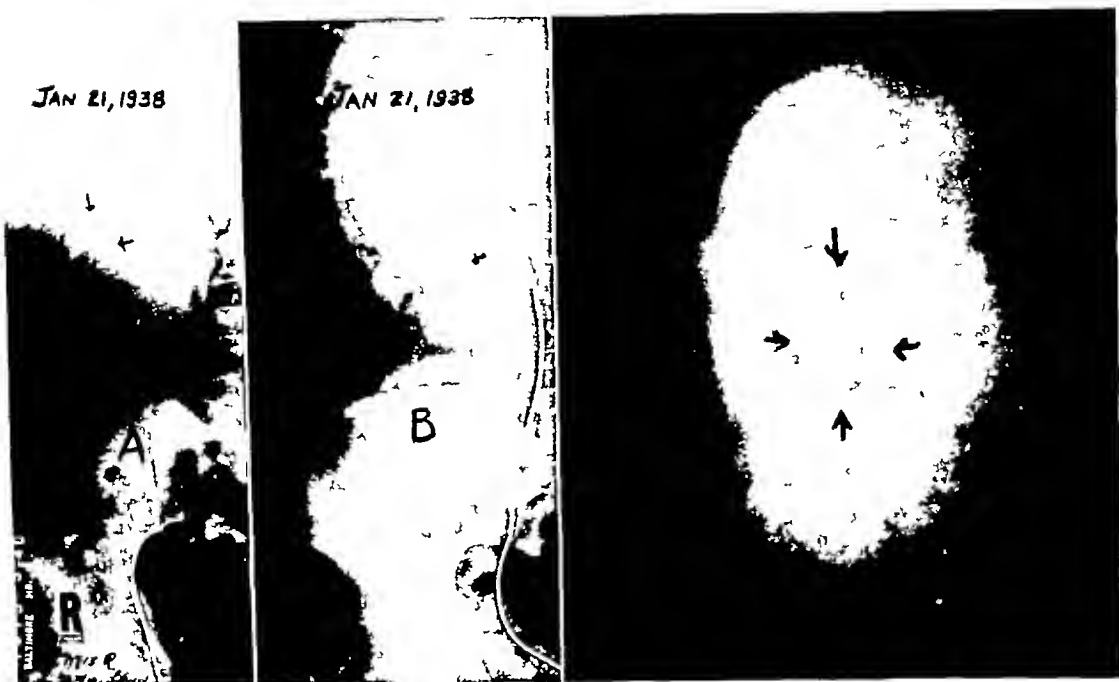


Fig 16 (left) Case XVII The area of calcification in the right kidney, observed in 1927, is present in the plain film (A) taken exactly 11 years later. There is no apparent increase in the size of the shadow. The right stereoscopic pyelogram (B) shows a marked dilatation of the pelvis and calices with distortion of the pelvis and lower calices by a tumor mass on the posterior surface of the kidney. The calcified area appeared to be in the central portion of the tumor mass.

Fig 17 (right) Case XVII A roentgenogram of the right kidney and tumor obtained at autopsy shows the area of calcification to be in the center of the tumor mass.

not fluctuating. The urine showed a faint trace of albumin and contained an occasional pus cell. Intravenous pyelography failed to show any dye in the right kidney area after 40 minutes. However, in the right kidney area there was noted a large round shadow, extending from the twelfth rib to the iliac crest, within which was a calcified area comparable to that observed 11 years previously (Fig 16-A). The outline of the right kidney appeared to be superimposed upon the larger shadow. A stereoscopic retrograde pyelogram revealed a marked dilatation of the pelvis and calices, with elongation and distortion of the lower calices and pelvis. The kidney appeared to be anterior to the tumor mass and the calcification was adjudged to be within the tumor (Fig 16-B). A diagnosis of renal neoplasm with calcification was made.

During his stay in the hospital, the patient developed a progressive uremia

The phthalein declined from 10 to 3 per cent for two hours and the blood urea rose from 76 to 170 mgm per cent. The patient died on Jan 26, 1938. Autopsy disclosed a large hypernephroma ($12 \times 10 \times 8$ cm) on the posterior surface of the kidney with metastases to the liver and spleen. The area of calcification was found in the central portion of the tumor (Fig 17).

In retrospect, it appears that the right renal neoplasm was present at the time the left kidney was removed but unfortunately was not diagnosed. The calcification in the center of the right renal neoplasm apparently did not increase materially in size during the 11 years following the operation. Since the patient had not had any roentgenographic studies prior to the operation in 1927, it is impossible to state exactly how long the calcification had been present, but certainly one may state that its presence in this case was a

mary operable"—in other words, a case offering a good chance of cure, one in which by clinical estimate, the disease had not spread beyond the axilla, and in which no surgery or radiation had previously been employed

Every case had an aspiration biopsy, which was positive for carcinoma, before the irradiation program was started. The surgical wound of a formal biopsy precludes such a heavy radiation program. Aspiration biopsy tells us that the lesion is cancer, but does not give us many details concerning the type of cancer (A possible exception is colloid cancer). Those unfamiliar with the accuracy of this method of biopsy might naturally doubt that cancer had ever been present in the breast, if no cancer cells were found at operation. However, we have verified the aspiration diagnosis of breast tumors in many hundreds of cases during the past six years. Added proof of its accuracy is seen in these cases in which R E B 4 is noted in the breast, but active or atrophic cancer cells are found in the axillary nodes, where, for technical reasons, it is more difficult to deliver a sterilizing dose of radiation.

The doses delivered to the tumors have been calculated in terms of threshold dose (T E D), as ordinarily used at the Memorial Hospital. Up to the present time, this has seemed to us the most practical scheme. It will be possible to translate the doses (approximately) here given into terms of any unit which may later be adopted.

The cases in the radium pack series were treated with the four-gram pack, at a target-skin distance of 6 cm with a circular field of about 80 square centimeters. In general, the primary lesion was treated first, two ports (an anterior and a lateral) being used, and each receiving a treatment of 8,000 mg-hr on alternate days to a total of from 16,000 to 24,000 mg-hr per port. The treatment of the primary lesion was thus completed in a week or less. Following this, three axillary ports were treated, one each day (anterior, direct,

posterior) to the same total dose, if possible.

In the x-ray series the factors were 200 kv (peak), 0.5 mm copper and 3 mm aluminum filter, 50 cm target-skin distance, an intensity of about 60 r per minute, and fields varying from 80 to 250 square centimeters. The treatment of the primary lesion and the axilla were carried out in a single series (instead of completing the one before starting the other). In general, the same five ports were used as above, two to the breast and three to the axilla. Two ports were irradiated daily, with 300 r each (measured in air), to a total of from 1,200 to 2,400 r per port, the entire treatment thus requiring from three to four weeks.

Tissue doses were calculated from isodose curves made with a small "air wall" ionization chamber and water phantom. For the radium pack, the threshold dose at 6 cm is about 9,000 mg-hr, so that a case receiving 24,000 mg-hr per port received a dose on each skin area of 2.7 T E D. The dose in the depth of the tumor is, of course, the sum of the depth doses from the two beams. For x-rays the threshold dose is about 500 r, so that a field receiving 1,800 r had a skin dose of 3.6 T E D.

No attempt has been made to calculate the doses for the axilla, possibilities for error here being considerably greater than in the case of the primary breast lesion.

No claim of accuracy is made for the doses arrived at. It is recognized that several factors contribute to error, both in the original measurements of the mass, and in uncertainty as to whether the beam of radiation strikes the tumor exactly as it was intended. However, we do feel that the approximations made are sound, and that worthwhile conclusions may be drawn from the material here presented.

Approximately 300 operable cases of breast cancer have been treated by this method since we began the work in 1933. Many of these were treated since the completion of this report. We have selected 201 case histories, containing sufficient data and details of tumor depth,

- CASE, J T Am Jour Roentgenol , 1914-1915, 2, 607
- CAULK, J R Trans Am Assn Genito-urin. Surg , 1912 7, 228
- Idem Trans Am Urol Assn , 1915, 9, 408
- Idem Jour Urol , 1921, 6, 97, 1931, 26, 189
- CHIARI H Wien med Wchnschr , 1878, 1, 6
- CHOWN B Canad Med Assn Jour 1936 35, 134
- CLUTE, H M Surg Clin. No Am 1924 4, 1453
- COHNHEIM, J Virchow's Arch f Path u path Anat 1875, 65, 64
- Idem Vorlesungen über allgemeine Pathologie A Hirschwald, Berlin, 1882 1, 617
- COLSTON, J A C Trans Am Assn Genito-urin Surg , 1931, 24, 13, Jour Johns Hopkins Hosp Bull , 1932, 51, 125
- CONYBEARE J J British Med Jour , 1930, 33, 515
- COOKE Quarterly Jour Med 1933 2, 539
- CRABTREE E G Trans Am Assn Genito urin Surg 1930, 23, 17
- CRAIG and LEE BROWN Surg , Gynec and Obst , 1928 46, 668
- CRENSHAW J L Jour Urol 1930 33, 515
- CROSBIE, A H, and PINKERTON H Jour Urol , 1932 27, 27
- CUNNINGHAM J H Surg , Gynec and Obst , 1916 23, 688
- CZECH, E Ueber Kalkmetastase Dissertation Würzburg 1895
- DAMM E Ztschr f urol Chir , 1932, 35, 102
- DAL R V Discussion of Delzell and Harrah, Jour Urol , 1928 19, 31 389
- DE RUYTER T H Acta Brevia Neerl 1934, 4, 1225
- DESNOS E Jour d'Urol 1923, 16, 449
- DEWITT Jour Radiol 1923 4, 400
- DIAMANTIS, A Jour d'Urol 1932 34, 264
- DICKINSON W H On Renal and Urinary Affections William Wood & Co N Y , 1885 p 68
- DIETLEN Ztschr f Röntgenkunde 1911 13, 85
- DIXON W E and HOYLE, J C British Med Jour 1928 2, 832
- DOCRAY On Experimental Calcification Dissertation Victoria University Manchester, England, 1988
- DOMRICH H Ztschr f Urol 1934 28, 836
- DOUILLAND Quoted by Gruber *loc cit*
- EBSTEIN W and NICOLAÏER, A Virchow's Arch f Path u path Anat 1897 148, 366
- Idem Ueber die Experimentelle Erzeugung der Harnsteinen J F Bergman Wiesbaden 1891
- EISENDRATH D R Surg Gynec and Obst 1935 60, 77
- ELLIOTSON Quoted by Rayer and Roberts *loc cit*
- ELLIS R. W B Proc Roy Soc Med 1935 28, 1328
- ETTINGER A and MACENDANTZ H Am Jour Roentgenol and Rad Ther , 1934 31, 593
- FABRICIUS J Ztschr f Chir 1911 110, 323
- FAHR Quoted by Lubarsch *loc cit*
- FAHRE A Deutsche Ztschr f Chir 1934 243, 628
- FEDEROFF S P Ztschr f Urol 1930 24, 571
- FELDMAN M RADIOLOGY 1934 23, 700
- FISH G W and HALLOCK L A Jour Am Med Assn 1931 96, 1935
- FLEISCHER and HANSEN C C Hospitalstid Sept 17 1935
- FRAENKEL A Ztschr f klin Med 1881 2, 664 quoted by Bolognesi *loc cit*
- FRANKLEN Quoted by Baroni *loc cit*
- FUGIMAKI Y Japan Med World 1926 6, 2
- GALVEZ I and GARATI F O Rev Asoc Med Argent 1932 46, 803
- GARCEAU C Renal Urteral, Perirenal and Adrenal Tumors Appleton & Co N Y 1909
- GASSMAN, T Ztschr f physiol Chem , 1930 192, 161
- GAUGELE K Arch f klin Chir 1907, 83, 959
- GIBSON, T Jour Urol , 1935, 33, 445
- GIERKE, E Virchow's Arch f Path u path Anat , 1902 167, 318
- GIERKE and FRANKEL Quoted by Baroni, *loc cit*
- GLASERFELD E Virchow's Arch f Path u path Anat , 1907 188, 92
- GOLDENBERG München med Wchnschr , 1910, 36, 1915
- GOLDSCHMIDT Beitr z pathol Anat u allg Pathol , 1913, 56, 77
- GOLDSTEIN, A E , and ABESHOUSE, B S Arch Surg 1935, 31, 943
- GOTTSCHALK Ueber die Einseifung des Aloms auf den Körper, Speziellen der Niere Inaugural Dissertation, Leipzig 1882
- GRAY, J British Jour Surg , 1935, 23, 458
- GREENBERG, D M , and SCHMIDT, C L A Jour Gen Physiol 1925, 8, 271
- GREENWALD, I , and GROSS, J Jour Biol Chem , 1925, 66, 185 201 207 *idem* 1926, 68, 325
- GRIMALDI, F , and CASTANO, E Rev Asoc Med Argent , 1924-1925, 37, 149
- GROESCHEL, L B Am Jour Roentgenol , 1921, 8, 641
- GROSLIK Monathuch f Urol 1906 11, 457
- GRUBER, G B Henke and Lubarsch, Handbuch der spec path Anat u Histol J Springer Berlin, 1925 6, 23, 25 28
- GUILLAS, R Urology D Appleton and Co , N Y , 1912 2, 115
- HAENISCH G F Fortschr a d Geb d Röntgenstrahlen, 1909-1910, 14, 7, 15, 300
- HANNING, R B , and POOLE F E Arch Path , 1936 21, 44
- HALL F H Arch Int Med , 1908 2, 356
- HARBITZ F Jour Med Research, 1915 32, 361
- Idem Norsk Mag f Lægevidensk , 1917, 78, 1129
- HARLOW F W and AFIFI M A Urol and Cutan Rev , 1930 34, 575
- HASTINGS, A B MURRAY C D and SENDREX, J Jour Biol Chem 1927, 71, 723
- HEDREN Beitr z path Anat u allg Path 1907, 40, 1 107
- HEIDENHAIM Arch f d ges Physiol 1874 9, 23
- HEINCKE, H Fortsch a d Geh d Röntgenstrahlen 1909 13, 231
- HELLSTROM, J Ztschr f Urol 1931 25, 401
- HERBST and VYNALSK Jour Am Med Assn , 1931 96, 597
- HERSKOVITZ E Röntgenpraxis, 1936, 8, 560
- HEYMAN E Zentralbl f Chir 1925 57, 1262
- HIGGINS C C Jour Urol 1933 29, 157
- HILDEBRAND O Arch f klin Chir 1924 pp 130-137
- HINMAN F Practice of Surgery, Edited by Dean Lewis W F Prior Co Hagerstown, Md 1926, 8, 2 (Chapter 9)
- HLAVA Wien med Blatter 1882, 36, 38
- HOFFHEINZ Virchow's Arch f Path u path Anat 1925 256, 705
- HOFMEISTER F Ergebn d Physiol 1910 10, 429
- HOLMES R J and COPLAN M M Jour Urol 1930 23, 477
- HOLT L E LA MER V K , and CHOWN H B Biol Chem , 1925 64, 509
- HOPPE SEYLER, F Ztschr f physiol Chem 1891 15, 161
- HOPPE-SEYLER, G Ergebn d Physiol 1910 10, 429
- HOWLAND, J Medicine 1923 2, 349
- HOYLE J C Jour Exp Pharm and Exp Ther 1930 40, 351
- HUEPNER W Arch Path 1927, 3, 14
- HUGGINS C B Proc Soc Exp Med 1930 27, 349 1933 27, 203
- ILLIES Folia Urologica 1912 6, 691

arbitrary rating for these terms if they were to be of comparative value. In Table II will be found the one agreed upon.

In Table III we have compared the degree of clinical regression with the microscopic radiation effect observed by the pathologist, for all cases in which a statement of clinical opinion was found on the history. It is seen that some tumors had completely disappeared clinically which were rated by the pathologist as showing no radiation effect (R E B 0), there were actually 10 such cases in the series of 56 R E B 0 cases, or 18 per cent. It is probable that the residual disease was obscured by edema of the surrounding tissues, or by fibrosis and infiltration incidental to irradiation. Areas of mastitis in the breast also increase the chance of error in clinical impression. There is also the possibility that the fully viable and unaltered cancer cells found in the breast were manifestations of renewed activity of the tumor, but this is extremely unlikely.

A high percentage of the cases which showed little or no clinical regression showed R E B 0, and those cases showing apparent complete clinical regression usually demonstrated marked destructive effect on the cancer. In general, therefore, it may be stated that the greater the clinical regression, the more likely the tumor is to show a high radiation effect. *Of the x-ray and radium cases 71 per cent and 75 per cent, respectively, which were stated to show complete regression, showed either complete microscopic absence of cancer cells,*

or else only a few scattered and badly damaged ones. Hence, we feel that the clinical impression can be fairly well relied on to follow the scale of radiation effects. We may state that in approximately three out of four cases which show complete clinical regression, the radiation effect in the tumor will be profound.

This study naturally leads to a consideration of the amount of effective radiation delivered to tumors (T E D) showing varying grades of clinical regression. In Table IV the dose of radiation (T E D) is compared with the amount of clinical regression. For purposes of analysis, cases were grouped as to whether the calculated effective tumor dose was less than, or greater than, 4 T E D in the x-ray group, and less than, or greater than, 1.5 T E D for the radium group. The figures would indicate that, as is to be expected, the percentage of cases showing the advanced stages of clinical tumor disappearance increases as the higher calculated tumor doses are reached. For example, in the x-ray group 34 per cent of the cases with a calculated tumor dose of less than 4 T E D showed "clinical regression Grade 3," whereas 57 per cent of the group with calculated dose of greater than 4 T E D showed the same amount of advanced clinical regression. In other words, of the 58 cases receiving x-ray therapy, 57 per cent of the tumors clinically disappeared if they received more than 4 T E D, while only 34 per cent of the tumors clinically disappeared if less than 4 T E D were given.

TABLE IV — COMPARISON BETWEEN CLINICAL REGRESSION AND THRESHOLD DOSES

X rays

T E D	Total No Cases	Clinical Regression							
		0		1		2		3	
		No	Per Cent	No	Per Cent	No	Per Cent	No	Per Cent
Less Than 4	58	12	21	17	29	10	17	20	34
Greater Than 4	58	7	12	12	21	6	10	33	57
Radium									
Less Than 1.5	21	2	10	6	29	2	10	11	52
Greater Than 1.5	28	2	7	2	7	1	4	23	83

- NEWMAN Quoted by Morris, H *loc cit*
 NOBLE, T B Jour Bone and Joint Surg, 1932, 14,
 181
 NURNBERG, F Frankf Ztschr f Pathol, 1907, 1,
 433
 O CONNOR V J Jour Am Med Assn 1925, 85,
 118
 OEHLECKER F Ztschr f urol Chir 1922 10, 47
 OPPENHEIMER K Centralbl f allg Path u path
 Anat 1923 33, 537
 OSBORNE T B, MENDEL L B and PERRY E L
 Jour Am Med Assn 1917, 69, 32
 PARRIERA, H and CASTRO FRIERE Compt Rend
 Soc de Biol 1926, 95, 1592
 PATRASSI, G Arch di Pat e Clin Med, 1930, 10,
 104
 PAULI, W, and SAMBOC M Biochem Ztschr, 1909
 17, 235
 PEARCE, R M Jour Med Research 1909 20, 53
 PENECKE R Centralbl f allg Path, 1926 37, 535
 PEREZ CASTRO E Beitr z path Anat u z allg
 Path 1937 pp 99-107
 PERLA D, and HUTNER L Am Jour Path 1930
 6, 235
 PERLMAN S and WEBER W München med
 Wehnschr 1930 77, 680
 PERUSSIA Quoted by Arkin *loc cit*
 PETERS J P and VAN SLYKE D D Quantitative
 Clinical Chemistry Williams and Wilkins Baltimore,
 1931 p 805
 PETERS J P and EISENBERG L Jour Biol Chem
 1929 84, 155
 PFANNENSTIEL W Klin Wehnschr 1927 6, 2310
 PHENISTER D B Ann Surg 1923 78, 239
 PICK Quoted by Huggins *loc cit*
 PIRODINI E Policlinico (Sez Chir) 1917 24,
 339
 PLESCHNER H G Ztschr f urol Chir 1913 1,
 309
 POCHARISSEY J F Beitr z path Anat u z allg
 Path 1905 38, 135
 PONZIO M Arch d Electric Med Exper et
 Clin Bordeaux 1913 2, 258
 PREVOST and BINET Quoted by von Kossa *loc cit*
 PUGH, W Urol and Cutan Rev 1927 31, 208
 Idem Internat Jour Med Surg 1927 40, 288
 PUTSCHAR W Ztschr f Kinderheilk 1929 47,
 269
 PUTTI Quoted by Bolognesi *loc cit*
 RABL C R Virchow's Arch f Path u path
 Anat 1923 245, 543
 Idem München med Wehnschr 1924 21, 202 468
 RACIC J Ztschr f Urol 1934 28, 292
 RANDALL A Trans New England Branch Am
 Urol Assn Boston 1935
 Idem Surg Gynec and Obst 1937 64, 201
 Idem Ann Surg 1937 105, 1009
 RATSCHITCH J Jour d Urol 1924 18, 297
 RAVICH A and TURKELTAUB S M Urol and
 Cutan Rev 1936 40, 172
 RAY M V Am Jour Cancer 1935 24, 839
 RAYER P Maladies des Reins J B Baillière
 Paris 1841 3, 605-612
 RIBBERT Geschwulstlehre Bonn 1904
 ROBERTS D R C British Med Jour 1930 12,
 876
 ROBERTS W A Practical Treatise on Urinary and
 Renal Diseases H C Lea Philadelphia 1872 p 455
 ROBISON R Biochem Jour 1923 17, 286
 ROHNBURG G L Jour Cancer Research 1918
 3, 193
 ROSENBERG W Jour Urol 1937 38, 251
 ROSENHEIM A H and ROBISON J Biochem
 Jour 1934 28, 712
 ROSING Quoted by Arkin *loc cit*
 SACERDOTTI C and FRATTINI G Arch path
 Anat u Physiol 1902 168, 431
 SCHALL L Deutsche med Wehnschr, 1931, 57,
 1975
 SCHEGTENDAL, B Langenbech's Arch, 1887, 36,
 304
 SCHINCHELIO ULENO Quoted by Bolognesi *loc cit*
 SCHMIDT M B Die Verkalzung, Handbuch d
 allg Path von Krehl und Marchand 3, 215 (Part 2)
 Idem Deutsche med Wehnschr, 1913 39, 59
 Idem Centralbl f allg Path u path Anat 1920
 30, 497
 SCHNORL Verhandl d deutsch Pathol Gesellsch.,
 1930 25, 190
 SCHONENBERGER Virchow's Arch f Path u path
 Anat, 1901, 165, 189
 SCHULTZE F Arch f klin Chir 1921 118, 411
 Idem Mitth a d Grenzgeb d Med u Chir 1923,
 26, 243
 SENATOR, H Handbuch der Spec Pathol u
 Therapie, Edited by Vogel, Leipzig 1875 12, 209
 (Part I)
 SENDREY J and HASTINGS A B Jour Biol
 Chem 1927, 71, 783, 797
 SHERLING D H Proc Soc Exp Biol and Med
 1930 28, 301
 SMART M British Med Jour 1905 2, 617
 SMITH M I and ELVOYE E Pub Health Repts,
 1929 44, 1245
 SODERLUND G Folia Urologica 1913, 7, 75
 Idem Nord Med Arkiv 1925 158, 649
 SSOROKA N S Ztschr f Urol 1931, 25, 738
 STADE, F Ueber Lungenverkalzungen Disserta-
 tion Kiel 1900
 STAUB V Beitr z path Anat u z allg Path
 1927, 78, 67
 STEIBEL Rickets and Osteomalacia Virchow's
 Handbuch der Spec Path u Therapie F Enke,
 Stuttgart, 1854 pp 537-546
 STERLING W C and LAWRENCE C S Jour Am
 Med Assn 1924 82, 25
 STEVENS A R Urol and Cutan Rev 1933 37,
 526
 STEVENS W E Jour Am Med Assn 1927 88,
 71
 STOPPATO U Jour d Urol 1923 16, 449
 STRAUS A A Surg Gynec and Obst 1914 17,
 78
 STRAUSS L Ztschr f urol Chir 1931 33, 267
 STUART J C Quoted by Pugh *loc cit*
 STUART G and KIRKORIAN K S Jour Path and
 Bacteriol 1932 35, 373
 TANAKA M Biochem Ztschr 1911 35, 113
 1912 38, 235
 TARTARINI GALLERANI Quoted by Bolognesi *loc
 cit*
 TATERKA H and DENKIN L Deutsche med
 Wehnschr 1927 53, 1054
 TAYLOR N W and SHEARD G Jour Biol
 Chem 1929 81, 479
 TEDESCHI C Arch Ital d Urol 1930 7, 100
 THATCHER D Edinburgh Med Jour 1931 38,
 457
 THIEDE Mischgeschwulste der Nierencapsule In-
 augural Dissertation Berlin 1913
 TILLIER H Bull et Mem Soc de Radiol Med de
 France February 1937 25, 144
 TURNER Quoted by Walsh and Norton *loc cit*
 UTHOFF C J Urol and Cutan Rev 1936 40, 559
 VALENTINE J J Am Jour Surg 1929 6, 93
 VAN LEERSUM E C Jour Biol Chem 1928 76,
 137 79, 461
 VERSE M Centralbl f allg Path u path Anat
 1910 21, 459
 Idem Beitr z path Anat u z allg Path 1912
 53, 212
 VINCENT Quoted by Rayer *loc cit*
 VIRCHOW R Virchow's Arch f Path u path
 Anat 1855 8, 103

group the majority of the cases received less than 25,000 mg-hr per portal. Of the cases receiving less than 1,800 r per skin portal, 22 per cent showed a calculated tumor dose of greater than 4 T E D, while 67 per cent receiving greater than 1,800 r per skin portal showed the same calculated tumor dose (greater than 4 T E D). This point may be more clearly brought out if two of the x-ray dosage groups, *viz.*, the smaller and the larger, are contrasted (Table VII). Cases receiving 1,600 r on

TABLE VII—RELATION BETWEEN SKIN DOSE AND TUMOR DOSE

Skin Dose	Total No Cases	Tumor Dose			
		Less Than 4 T E D		Greater Than 4 T E D	
		No	Per Cent	No	Per Cent
1,600 r	26	18	62	10	38
2,400 r	29	6	21	23	79

the skin showed almost twice the percentage (62 per cent) with a calculated dose of less than 4 T E D when compared with those greater than 4 T E D (38 per cent). But when the dose on the skin is increased by 50 per cent (800 r) to 2,400 r, we find that the percentage of cases receiving a calculated minimum effective tumor dose of more than 4 T E D is almost four times the percentage (79 per cent) receiving less than 4 T E D (21). It is to be noted that 21 per cent of the cases of the 2,400 r group received less than 4 T E D and 38 per cent of the 1,600 r group showed a calculated tumor dose of more than 4 T E D. This emphasizes the fact that expressions of dosage per skin portal are insufficient to convey an accurate idea of the effective radiation delivered to any tumor. Analysis of the radium pack cases, in general, bears out this statement, but the number of cases is too small for statistical analysis.

An important factor in planning irradiation therapy is the size of the tumor. The larger the tumor and the deeper its posterior portion from the skin, the smaller the minimum effective dose of radiation

which can be delivered to it. In addition, the larger the tumor, the more likely are portions of it to lie off the center of the radiation beam. Since the percentage depth dose is appreciably less at the edges of the irradiated field than near its center, there is more likelihood that peripheral portions of the large tumors will be underdosed. In Table VII tumors of different sizes have been compared with their radiation effects. The grouping of tumors as to size is arbitrary. The limitations of the value of tumor size measurements of the clinician has been mentioned. However, we have grouped them as *small* tumors, if they were estimated to be 4 cm or less in diameter, and as *large* tumors if they were estimated to be larger than 4 cm. Table VIII shows that the percentage of profound radiation effects is higher (64 per cent) for small tumors, and lower (46 per cent) for the large tumors.

Since there is such a close relationship between the size of the tumor and the

TABLE VIII—RELATION BETWEEN SIZE OF TUMOR AND RADIATION EFFECT

X rays						
Radiation Effect	No Cases	Per Cent Total	Size of Tumor			
			Small		Large	
			No	Per Cent	No	Per Cent
0	54	39	23	43	31	57
1 and 2	28	20	13	46	15	54
3 and 4	56	40	36	64	20	46
Radium						
0	25	40	12	49	13	51
1 and 2	14	22	8	57	6	43
3 and 4	24	38	11	49	13	51

radiation effect obtained, it follows naturally that a comparison of the *calculated minimum effective tumor doses with the size of the tumors* will show a similar relationship. Table IX shows such a comparison. It is natural that this should be true, since it has been shown that the radiation effect on the tumor is directly related to the dosage received by it (see Table V). Thus,

A ROENTGENOLOGICAL STUDY OF PINEAL ORIENTATION

II A COMPARISON OF THE GRAPHIC AND PROPORTIONAL METHODS IN PROVEN CASES OF BRAIN TUMOR

By WALTER W FRAY, M D, M S, Rochester, N Y

From the Department of Medicine, Division of Radiology of the University of Rochester School of Medicine and Dentistry and Strong Memorial Hospital

IN a previous communication, (1) the comparative accuracy of the original graphic method of pineal localization of Vastine and Kinney (2) and the pro-

of the pineal from the calvarium does not vary directly with the size of the skull. The proportional method¹ which we have devised is based on strict proportionality

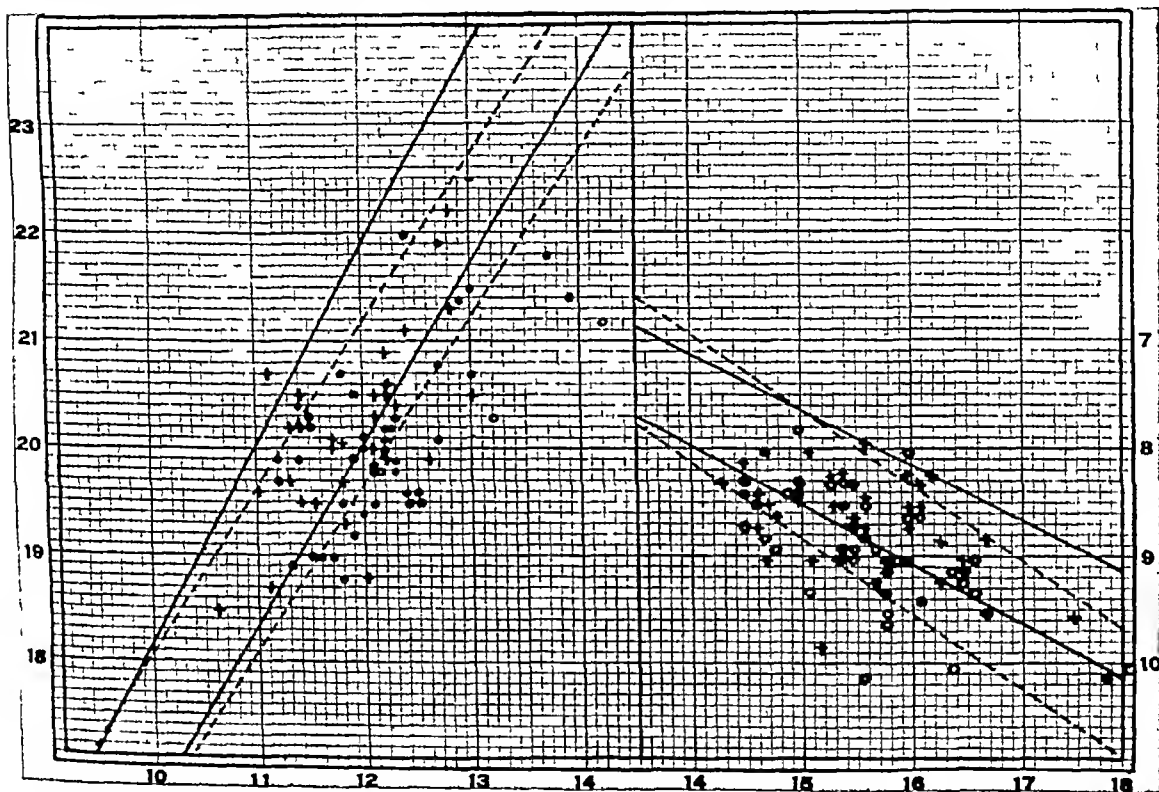


Fig 1 Distribution of pineals in a series of 64 brain tumors arising within the cerebral lobes, comparing the graphic method (broken lines) with the proportional method (solid lines). Symbols O = frontal, + = temporal, ● = parietal. The proportional method shows a greater number of cases with displaced pineals (posterior or downward displacement).

portional method recently devised by the writer was determined in 104 cases of normal skulls. The graphic method was derived in 1927 by directly plotting the position of the gland in respect to selected points on the calvarium with a corresponding diameter of the skull on graph paper and delimiting a normal zone after a study of known normal cases. The method when analyzed is found not to be a proportional method, *i e*, the distance

and does not require any direct measurements of the film nor does it require a graph for its interpretation, a mechanical guide

¹ Since paper's completion the writer has learned that J D Camp, M D of Rochester, Minn. exhibited before the College of Radiology in 1933 a pineal localizer employing a coil spring with proper markers. In a personal communication he states that he did not publish a description of his device because of manufacturing costs. It is of no little interest to note however that the underlying principle of his device is similar to the writer's proportional method—the uniform stretching linearly of a calibrated material.

evident that, in tumor no less than in skin, it is impossible to make a comparison of the radiation effect of radium and x-radiation on the basis of total dose alone

SUMMARY

A series of 201 cases of primary operable mammary cancer were subjected to pre-operative irradiation, of varying amounts

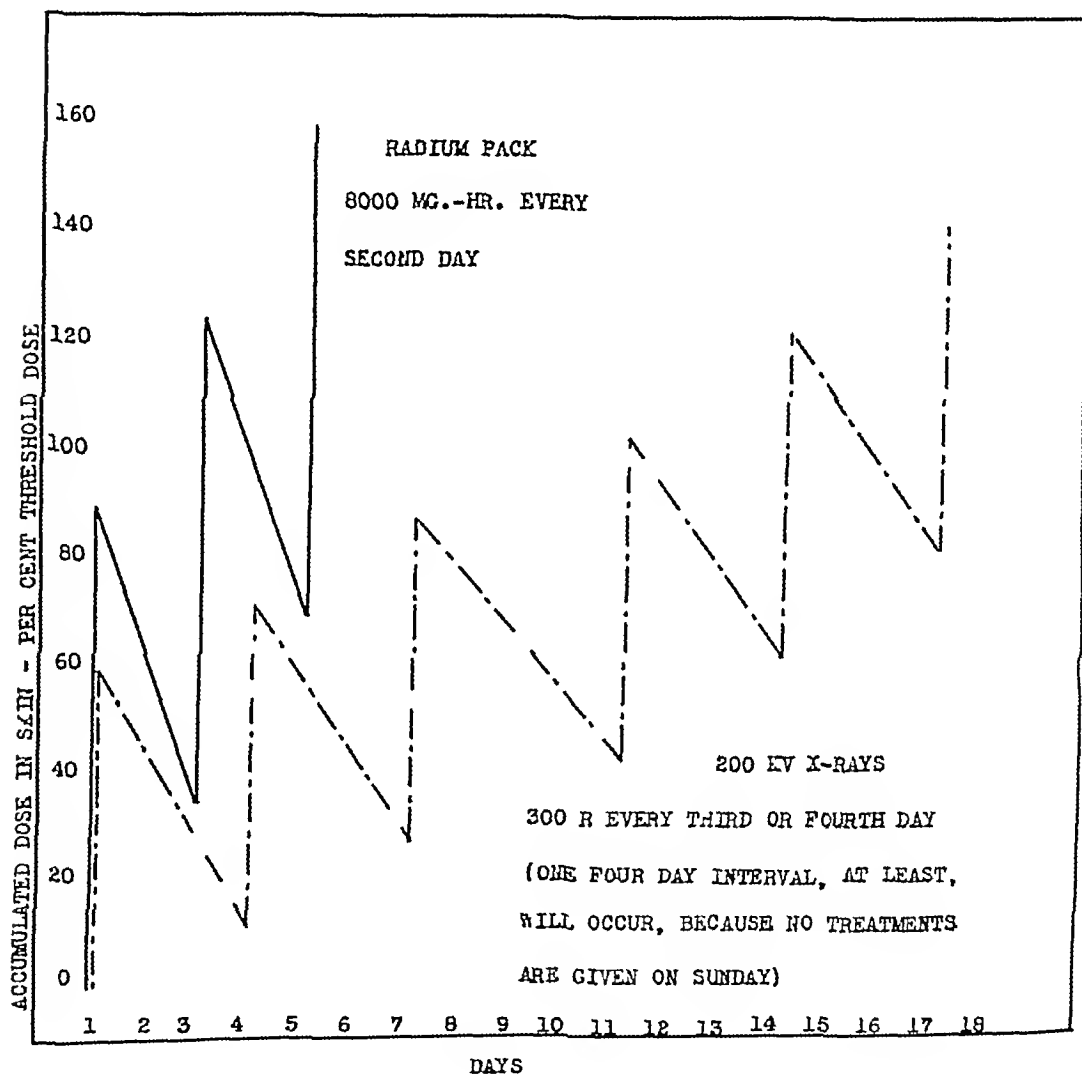


Fig 1

These facts must be borne in mind in considering the data submitted. Whereas on the basis of total radiation administered, the radium appears considerably more efficacious in producing tumor regression, on the basis of the cumulative dose, such an advantage of radium is not apparent.

138 cases were treated by the 200 kv x-rays, and 63 cases by the 4-gram radium element pack. After approximately from eight to ten weeks following completion of the pre-operative irradiation, a radical mastectomy was performed. The tissues were then subjected to meticulous pathological study.

particularly when the proportional method was employed. Displacement, inferior or posterior, was identified in 18 out of 37 cases (approximately one-half of the cases) by the graphic method, and in 28 out of 37 cases (approximately three-fourths of the cases) by the proportional method. The graphic method gave a paradoxical result in one case in which anterior displacement was indicated. A lateral shift from the midplane of the skull was identified in slightly over half the cases of frontal tumor (56 per cent). The question might arise whether a frontal tumor can be present as a space-occupying mass within the frontal region which cannot be detected by measurements of either the anteroposterior or lateral skull films. This can occur and was noted in three cases of this series. It is uncommon, however, and a finding of a normally placed pineal on both the anteroposterior and lateral skull films makes a tumor of this region unlikely if the proportional method is used in measuring the lateral films and the measurements of the anteroposterior film are made in the manner described in a previous communication (3).

Tumors arising within the other lobes of the cerebrum (chiefly temporal or parietal tumors) less commonly produce displacements which can be detected from an analysis of the lateral film. When displacement was present, the direction of the displacement was either backward, downward, or a combination of the two as in frontal tumors. Forward displacement was not observed even in cases of tumor located as far posteriorly as the parietal region. The few occipital tumors which have been verified in our clinic have not shown calcified pineals except in one instance, and we have very little information relative to the type and frequency of pineal shifts in these uncommon tumors. In our series, tumors in the temporal or parietal lobe are much more apt to produce a lateral shift from the midplane position than in cases of frontal tumor. In 18 cases in which the pineal could be identified on

the anteroposterior film, lateral displacement was found in all.

Cerebellar tumors commonly show no consistent type of displacement which can be detected by measurement of the lateral skull film (Fig 2). In the few cases in which displacement was indicated, the direction of the displacement was upward or upward and forward. Six out of 21 cases were found displaced in this manner by the graphic method and three by the proportional method. In the two cases in which forward displacement alone was noted, it became doubtful if this displacement was real, since the skulls of these two cases were dolicho cephalic, a condition recognized as a frequent source of error when the graphic method is employed. Such forward displacement was absent if the proportional method was used. There was a single case in which the displacement appeared paradoxical, the pineal being shifted posteriorly by both the graphic and proportional methods. A more detailed examination of this case indicates a possible explanation of this finding. The sella was enormously enlarged, with marked erosion, and associated with it was a pronounced dilatation of the third ventricle. It is quite possible that the enlarging ventricle had pushed the pineal backward at its posterior margin in the direction of the tumor. A lateral shift of the pineal from the midplane is not observed in cerebellar tumors.

Sellar tumors and tumors about the third ventricle may show the pineal outside the normal zone occasionally (Fig 3). The former tend to place the gland above the normal zone and at times in front of it, while those about the third ventricle may displace the gland backward and downward. The enlarging and changing shape of the head in pituitary disease may account to a major degree for the apparent displacement of the pineal. The pituitary in enlarging could not produce an actual shift of the pineal forward in the direction of the tumor, but the changing shape of the head might result in an apparent shift. A lateral shift from the mid-

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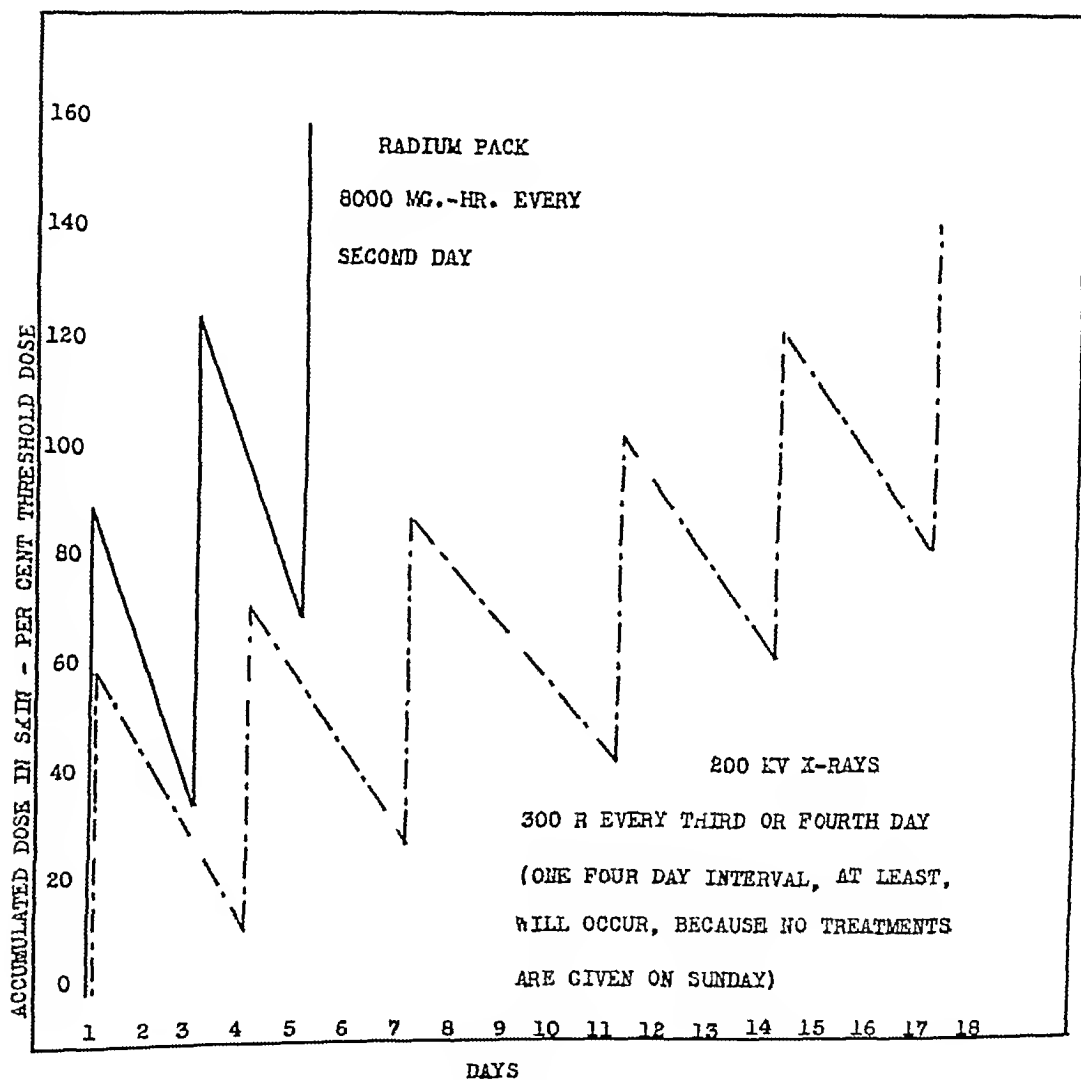


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PRACTICAL ASPECTS OF CALCIFICATION AND OSSIFICATION IN THE VARIOUS BODY TISSUES

By BERNARD P WIDMANN, M D , HERMAN W OSTRUM, M D , and
HERBERT FREED, M D , Philadelphia

From the Department of Radiology, Philadelphia General Hospital

THE recent unfolding of many new facts concerning the mechanisms of calcification, with the concomitant descriptions of new syndromes such as hyperparathyroidism and hypervitaminosis,

(A) *Blood Plasma Calcium*—A large part of the calcium in the diet must be brought into solution before absorption. This is dependent upon several factors. The soluble salts are thrown out of solu-



Fig 1

Fig 1 Decalcification of the lumbar spine and bones of the pelvis and several calculi in the left kidney the result of hypercalcemia in hyperparathyroidism with metastatic calcification in the kidney



Fig 2

Fig 2 The entire left kidney and ureter up to the cystic opening show fine granular calcification outlining the entire kidney and ureter This granular calcification resembles the healed milary tuberculosis in the lungs and here it also represents calcification of milary tubercles

makes the consideration of the entity, "Calcification and Ossification in the Various Body Tissues," a subject of signal interest to the roentgenologist (1, 2, 3) It is not generally appreciated that there are numerous factors governing calcification, and almost as many theories of the mechanism involved have been propounded

FACTORS CONCERNED IN CALCIFICATION

The following brief discussion of the most important factors is of special importance in understanding pathologic calcification in the various tissues (4)

tion by (a) the alkaline carbonates in the digestive juices, (b) by fatty acids The dependence of calcium metabolism upon a normal fat metabolism explains the abnormally low blood calcium values and also the poor absorption of vitamin D, resulting in the bone changes we see in the so-called celiac rickets Again, acidity of the intestinal contents favors the increased absorption of calcium, otherwise excess phosphorus must be balanced with that of calcium, or excess phosphorus combines with calcium as the insoluble calcium phosphate and causes calcium deprivation

mesencephalon, one cerebellar, one corpus callosum, and four frontal. The reason for lack of displacement lies in the fact that

emphasizes the importance of identifying the pineal on all anteroposterior or postero-anterior films whenever possible, re-



Fig 4 Right frontal glioma. There were no reliable localizing signs clinically. An attempt at ventriculography was not successful. The pineal falls within the normal zone when the graphic method is employed (broken line). The proportional method indicates posterior displacement. The measurements of the anteroposterior films indicate a definite lateral shift (to the left).

many of these gliomas lie either at or close to the midline, often at the base of the cranium. The exception is found in frontal tumors, four of those showing no displacement (four out of 11 cases).

There were 26 cases of meningiomas in this series with calcified pineals, in 50 per cent of the cases the pineal was found displaced by the graphic method, and 58 per cent by the proportional method on the lateral film. A lateral shift to the right or left of the midline was a frequent finding, occurring in 10 out of 12 cases. Of the two cases showing no shift, one was located beneath the tentorium and the other arose from the tuberculum sellæ. Of the 10 cases noted displaced on the anteroposterior film, five, or one-half, showed a normal position on the lateral film. This

peating the films if necessary to secure this information. This film often gives the sole localizing information to be obtained during the routine examination of the skull.

In this series there were 11 neurinomas which characteristically showed no displacement of the pineal. However, in this form of tumor, the direct evidence of destruction of the apex of the petrous pyramid usually gives all the localizing information necessary. While displacement of the pineal was not evident from measurement of the anteroposterior and lateral skull films, exceptionally a displacement upward was evident (two out of 11 cases). The conclusions were essentially the same, whether the graphic or proportional methods were used, except that in two of the



Fig 6



Fig 7

Fig 6 Extensive calcification of the superficial and deep cervical glands axillary glands occurring in glandular tuberculosis of the bovine type Other films, not shown here, also demonstrate extensive calcification of the abdominal glands

Fig 7 Irregular blotchy calcification in lower half of left lung occurring in the pleura as a result of an old empyema with calcification of the empyema wall



Fig 8-A



Fig 8-B



Fig 9

Figs 8 A and 8 B Irregular areas of calcification in the soft structures surrounding the articulating portions of the bones of the right knee as a result of a primary osteogenic sarcoma

Fig 9 Nodular areas of calcification in both lungs and hilar regions as a result of metastatic osteogenic sarcoma, the primary lesion being in the right hip

glands on calcium metabolism, though less marked, is definite Thyroid extract pro-

duces an increased excretion of calcium (9, 10), and rarefaction of bones has been ob-

brain, subdural hematoma, epidural abscesses, pachymeningitis hemorrhagia interna, often showed a lateral shift of the

the results of the methods and second, a consideration is given to importance of the lateral shift



Fig 6 Astrocytoma involving portions of right frontal, temporal and parietal lobes. In spite of the massive size of this tumor, the measurements by the Vastine and Kinney method fall within normal limits (indicated by broken lines), while the proportional method shows the gland to lie posterior to the normal zone (solid lines)

pineal in our cases and in several of them there was also evidence of a shift downward or backward. Accurate measurements of the anteroposterior film are of chief importance when unilateral fluid collections are considered, since these conditions commonly show only a lateral shift.

DISCUSSION

In estimating the value of the graphic or proportional method, one must eliminate all lateral shifts from consideration since these two methods involve only measurements of the lateral skull film. For example, temporal tumors more often than not, produce no shift that can be detected by measuring this film, but a lateral shift from the midsagittal plane is present in practically all cases. Our results are summarized, first, comparing

Vastine and Kinney reported displacement of the pineal either backward or downward in 25 out of 35 frontal tumors (slightly over two-thirds), and Dyke in 14 out of 26 cases (slightly over one-half) of gliomas and meningiomas. In our series, 18 out of 37 cases were found displaced either backward or downward by the graphic method (approximately one-half). In each of these three series, one case was noted in which the pineal was located either in front of or in front of and above the normal. Only one interpretation can be placed in this finding, namely, that misleading information may be given by this method. Many frontal tumors remain silent or are discovered late. Their bulk is considerable and it would appear unlikely that the pineal could be drawn toward it. Therefore, in the graphic method in nearly one-half the cases, the



Fig 14



Fig 15



Fig 16

Fig 14 Retrograde pyelogram showing normally outlined pelvis and calices in the right kidney and in the periphery of the inner and upper portions of the left kidney, dense linear calcification representing a cortical adrenal tumor portions of which have undergone necrosis followed by calcification

Fig 15 Several large circular calcified shadows, somewhat separated from one another, showing mottled, small, calcified shadows in the centers. Calcified echinococcal cysts in the liver

Fig 16 Small ovoid calcified shadows, about 1 x 3 mm in diameter, in the muscles of the back and thighs. These calcified shadows run parallel to the long axis of the muscles and represent calcified *Cysticercus* parasites

The frequency of calcium deposits in the alveoli of the lungs, the uriniferous tubules and the gastric gland areas which possess a slightly alkaline reaction because of eliminations of acid at these points, has been cited as evidence (19)

(F) *Phosphatase*—The enzyme phosphatase, apparently plays a major rôle as a catalyst and is present in particularly high concentrations in the growing portions of the bones of young animals (20). It apparently acts on phosphoric acid esters reaching the tissues, causing the local liberation of phosphate ions and the resultant deposition of calcium phosphate. Phosphatase is increased not only in growing children but also in disease in cases in which extensive decalcification occurs, such as Paget's disease, osteomalacia, and rickets. With improvement, the phosphatase returns to normal.

(G) *Blood Supply*—Leriche and Policard (21) hold that there is a very important relationship between vascularity and calcification of bone, since the process of halisteresis is stimulated and accelerated by an increase in arterial blood. As a result,

we see decalcification of the bone with hyperemia of the area and osteosclerosis, if there is anemia of the diseased part.

METASTATIC CALCIFICATION

This is a condition of deposition of lime salts in tissues with increase of plasma calcium, usually due to some generalized rarefying disease of bone, and was first described by Virchow in 1855 (22). Nephritis is often present and may be of importance in causing a retention of calcium of the blood, but it is not invariably present. The causes of bone resorption which may give rise to metastatic calcification are many. Tumors, *e.g.*, sarcoma and carcinoma of bone (23, 24, 25), multiple myeloma (26), myelogenous leukemia (27, 4), osteosarcoma and caries of the spine (28, 29), hyperparathyroidism (Fig 1), and Albers-Schönberg disease. The significance of nephritis as a concomitant factor in the production of this condition has been emphasized by several writers and those cases in which nephritis was unassociated with other obvious changes demonstrate its importance (32, 33).

TABLE I—OUTLINE FOR AIDING IN LOCALIZATION OF TUMORS

Correlating the type of pineal shift with the possible locations of the tumor within the brain

Lateral Shift	B or D Shift *	F or U Shift *	Location of Tumor
0	0	0 or slight	Subtentorial or basilar mass near midline Rules out temporal and parietal tumors and renders frontal tumors unlikely
0	+	0	Frontal tumor or basilar midline mass above tentorium Rules out temporal, parietal, and occipital tumors, also subtentorial masses
+	0	0 or slight	Temporal or parietal tumors, less commonly frontal tumors Rules out cerebellar tumors
+	+	0	Frontal tumors, also temporal and parietal tumors Rules out cerebellar tumors
+	0	+	Occipital, less commonly temporal or parietal Rules out frontal Renders subtentorial mass unlikely

* B, D, F, and U indicate backward downward, forward, and upward, respectively

or downward favors a frontal mass but does not exclude a temporal or parietal tumor above the tentorium

6 The presence of a lateral shift combined with a forward or upward shift in the other plane of space may indicate an occipital mass or a sellar tumor and rarely a temporal or parietal mass

CONCLUSIONS

1 A comparison of the graphic and proportional methods in 147 verified cases of space-occupying masses within or at the surface of the brain revealed a correct interpretation of the position of the pineal in the higher proportion of cases by the proportional method than by the graphic method

2 This was particularly apparent in that group of brain tumors (frontal tumors) which commonly give either no or very uncertain localizing signs clinically In this group diagnostic accuracy in detecting a pineal shift was increased approximately from 50 per cent to 75 per cent

3 The presence, direction, and character of the pineal shift has been analyzed and correlated with the type and location of the tumor within the brain

4 By combining the information gained from the anteroposterior film regarding the presence or absence of a lateral pineal shift with the information or data gained from the lateral film by the proportional method, a tentative outline for aiding in the localization of tumors is proposed which may be helpful under the following conditions (a) the pineal is sufficiently calcified to permit its certain identification on both the anteroposterior and lateral films, (b) a shift can be identified on either the anteroposterior or lateral skull films or both This outline, it should be recognized, does not permit localization of all tumors but rather eliminates many regions as possibilities and aids in restricting the latter to a few locations

BIBLIOGRAPHY

- (1) FRAY, WALTER W A Roentgenological Study of Pineal Orientation I A Comparison of Proportional and Graphic Methods in Normal Cases Arch Neurol and Psychiatry, 1937, 38, 1199
- (2) VASTINE, J H, and KINNEY, K K The Pineal Shadow as an Aid in the Localization of Brain Tumors Am Jour Roentgenol and Rad Ther, 1927 17, 320-327
- (3) FRAY, WALTER W A Study of the Effect of Skull Rotation on Roentgenological Measurements of the Pineal Gland RADIOLOGY, October, 1936, 27, 433-441



Fig 20 A

Fig 20-B

Fig 20 A Postero-anterior view Large saccular aneurysm with dense linear calcification in the sac displacing the trachea to the right The heart is not enlarged

Fig 20-B Lateral view Showing the origin of the aneurysm from the mid portion of the arch the remaining portion of the aorta being normal There is some erosion of the anterior surface of the dorsal vertebra

tissue that does not suppurate, it usually becomes infiltrated with lime salts Besides the totally necrotic areas, the most frequently calcified areas are the masses of scar tissue that have become hyaline subsequent to impaired circulation by contraction of the tissue around the vessels This form of calcification is often called "dystrophic calcification" Probably the only exception to the rule that the tissue must be dead or dying before calcification occurs is in metastatic calcification

This form of calcification is most commonly seen in chronic tuberculous lesions (Figs 2, 3, 4, 5, 6), in the lining of chronic empyema cavities, (Fig 7), and in various tumors, both primary (Fig 8), and secondary (Figs 9, 10) The fibro-adenoma (Fig 11) of the uterus, lithopedium (Fig 12), the adenoma of the thyroid (Fig 13),

the hypernephroma (Fig 14), and other kidney tumors are relatively frequent sites of pathologic calcification Calcified parasites, while infrequent, cannot be dismissed by mere mention Calcification in the following organisms have been found by us The echinococcus (Fig 15), cysticercus cellulosæ (Fig 16), and trichina spiralis

The echinococcus cysts are larger than any of the other parasitic lesions Calcification usually starts in the outer wall as irregular plaques over a curved surface Finally the entire cyst may shrink and calcify The cysticercus calcification appears as a multiple ovoid Shadows, three-tenths to one centimeter in length, are scattered in the muscles, with their long axis in the principal axis of the body The calcified *Trichina* parasite is somewhat

the present, that this group may be capable of recurrence

"R E B 4—signifies that after a most careful study has been made of tissues taken from many portions of the breast, there is no sign of cancer "

In many cases the effect of radiation of the tumor was rated as zero, even though a large tumor had clinically disappeared under therapy. This may not mean that profound changes were not present, but that the pathologist has thought wise to be dogmatic in dealing with this point. He reasons that a case showing any unaltered cancer cells at operation, even though 99 per cent of the tumor has clinically disappeared, should be listed as "radiation effect, zero." The analogy to the removal by the surgeon of 99 per cent of the primary tumor is clear, as long as radiosensitivity and radiocurability are not confused.

The effect of radiation in bringing about tumor regression is very incompletely understood. It would, however, seem evident that for the desired reaction to be produced, a certain minimum amount of radiation must be delivered either to the tumor itself, or to tissues immediately surrounding it. Since tumors vary greatly in size, depth, and in the amount of overlying tissue, it is evident that, from the same x-ray beam, very different doses of radiation may be delivered to the deepest lying cells. Obviously, then, the specifications of radiation dosage as a certain number of roentgens, or of milligram-hours per port are entirely insufficient. It is possible for a small superficial mass to receive a much greater dose from 1,000 roentgens per port than a larger, deeply seated tumor from 2,000 roentgens per port. No really worthwhile information regarding the necessary dose of radiation will be available until the actual doses delivered to the tissues in question have been measured, in a large series of cases, and correlated with the observed effect.

From the point of view of the physicist the whole question of tissue dosage is in an unsettled state. No satisfactory unit

has been developed, especially for radium radiations. In recent years, physicists have devoted much time and thought to the problem, and it is to be hoped that something practical will soon be available. However, it is not necessary to wait for the perfect physical solution before starting the clinical work. If careful records are kept of the size, shape, depth, and position of the mass and of all the radiation factors, dosage may be specified in terms of any usable unit, and later translated to a new one if desired.

The object of this report is to present a correlation between the amount of radiation actually delivered to the tumor and the radiation effect resulting. When the dimensions and location of the tumor are known, it is possible from available physical data to calculate the minimum dose delivered to the lesion. By correlating these doses with the resultant radiation effects, it should be possible to determine the minimum dose which must be delivered if a satisfactory regression is to be hoped for. Such studies have been published for lesions primary elsewhere in the body (3, 4, 5, and 6). The effect of such factors as age of the patient, and interval between irradiation and operation have also been studied in these groups of cases.

In this report we have calculated the minimum dose delivered within the tumor mass, in two series of cases: one treated by the radium element pack and one by 200 kv x-rays, and the data, correlated with the resulting radiation effect in the tissues. The size, shape, depth, and position of the primary tumor were carefully determined, examinations being made by at least two clinicians, and many times, by four. The patient was assigned to the radium or x-ray group, as the case might be, and treatment was carried out accordingly. Subsequently, usually from six weeks to three months after irradiation was completed, a radical mastectomy was performed, and the entire breast and axillary contents subjected to careful pathological study.

Every case had been classified as "pri-



Fig 22 A (above) Calcinosiis circumscripta. Large irregular globular calcification near the right acromioclavicular articulation

Fig 22 B (below) Case similar to that shown in Figure 22 A. Dense amorphous calcification in the muscles and fascia of the lower half of the humerus

may be one in each side of the superior longitudinal sinus. Irregular calcification takes place in many meningiomas but they are never as large as calcifications in the falx, they are always multiple and tend to assume a round or oval shape. The extensive new bone formation with spicule development, so characteristic of meningiomas, is due to a bone reaction and must be distinguished from calcifications in the tumor itself. Somewhat similar calcification to that in ependymomas occurs in solitary tubercles but, according to Camp

(39), calcification in tubercles is compact and dense and this is not the case in ependymomas.

From 70 to 80 per cent of suprasellar cysts show calcification in their walls, a most important point to remember when treatment of a pituitary lesion is under consideration. A circular line of calcium above the sella is diagnostic of suprasellar cyst. In the same region one finds semilunar areas of calcification due to atheromatous plaques in diseased and aneurysmal carotid arteries. A patient with a cerebral abscess rarely lives long enough for calcification to take place in the walls of the abscess. Should he survive, calcification appears in thin round opacities similar to those seen in suprasellar cysts.

Much is now being written about calcification in the heart and blood vessels. Intracardiac calcification is most often seen in the aortic (Fig 19) and mitral valves and in the left annulus fibrosus. The tricuspid and pulmonary valves and right annulus fibrosus are rarely affected. The calcifications are multiple, usually semilunar or sabre-shaped, and can be distinguished from calcified costal cartilage or sternum (a) by their position in the heart shadow, (b) by characteristic dancing movement on the fluoroscopic screen. Bishop and Roesler (40) state that calcification of the aortic valve may be associated with calcified infarcts in the kidneys, hyperostosis of the frontal bone, and calcification of the nucleus pulposus of the intervertebral disks. Irregular calcification of the endocardium is sometimes seen in cases of subaortic stenosis.

Calcification of the myocardium is well known and is visualized radiologically in myocardial degeneration and infarct following coronary thrombosis. It has been described in cases of chronic sepsis and renal disease and in association with osteitis fibrosa cystica. Actual plaques in the coronary arteries have been demonstrated as linear, segmental, and curved shadows corresponding to the course of arteries.

Calcified plaques, the result of arteriosclerosis, occur very often in the walls of

shape, and size to permit of the desired calculations Table I indicates the distribution of cases between the two forms

TABLE I—RADIATION EFFECTS OBSERVED IN 201 CASES OF CARCINOMA OF THE BREAST TREATED BY PRE-OPERATIVE IRRADIATION

Radiation Effect Breast	Treated by X rays		Treated by Radium Pack	
	No Cases	Per Cent	No Cases	Per Cent
0	54	39	25	40
1	14	10	10	16
2	14	10	4	6
3	26	19	10	16
4	30	22	14	22
Total Cases	138		63	

of radiation therapy, namely, 138 x-ray cases and 63 radium pack cases. The radiation effects are recorded, and graded according to the Stewart scale above quoted. It is thought that grouping together R E B 3 and R E B 4 is justified. Dr Ewing and Dr Stewart feel that the R E B 3 cases show such severe radiation damage that they probably will not show a return to activity and will probably go on to complete sterilization. In that event, the end-results as far as radiocurability is concerned, would be the

same. In this analysis, the two groups will be placed together with the understanding that they do not represent exactly the same condition, as far as radiation effects are concerned. For purposes of analysis, it was likewise thought best to place together groups R E B 1 and R E B 2. While the changes observed in these groups are varied enough to allow the pathologist to differentiate them, the differences in the changes in either group are not so marked as to preclude their inclusion together for the purposes desired.

It is important to know whether the clinical opinion of degree of regression gives a true picture of the radiation effect obtained. The degree of clinical regression is frequently expressed in rather indefinite terms, which are, therefore, of relative value only. For purposes of analysis it was necessary to assign some sort of

TABLE II

Clinical regression Grade 0	Increase in size of tumor or no change
Grade 1	Slight decrease in size of tumor
Grade 2	Considerable decrease, "Marked decrease," Residual thickening only "
Grade 3	Complete clinical disappearance of tumor

TABLE III—COMPARISON BETWEEN RADIATION EFFECT AND CLINICAL REGRESSION OF BREAST CANCERS

X rays							
Clinical Regression	Total No Cases	R E 0		R E 1 and 2		R E 3 and 4	
		No	Per Cent	No	Per Cent	No	Per Cent
0	9	7	78	2	22	0	0
1	22	15	68	5	23	2	9
2	30	13	43	10	33	7	24
3	56	10	18	6	11	40	71
Radium							
0	2	2	100	0	0	0	0
1	5	3	60	2	40	0	0
2	14	6	43	7	50	1	7
3	28	6	21	1	4	21	75

fication due to injury, and (4) localized ossification (Fig 25), without a history of injury



Fig 25 Ossified hematoma in the lower portion of the left femur. The hematoma followed injury and later ossified.

Various theories have been advanced as to the cause of ossification in the muscles. The most plausible one is that the injury produces a hematoma and the coagulated blood is transformed into bone by way of fibrous tissues and cartilage. A tear of the periosteum may produce new bone formation. Infection in the muscles may be followed by ossification as a repair process.

In the generalized type, muscle bundles undergo transformation into bone without the history of injury. In the circumscribed form, localized ossification occurs from repeated trauma. When this occurs in the adductor longus, it is called "rider's bone" and when in the brachialis, it is known as "fencer's bone."

The ossification following injury is the most common type. The bone in the soft tissue is laid down in paths resembling muscle bundles lying parallel to the shaft and never arranged at right-angles. The

formation of bone in operative scars is produced by wandering osteoblasts, most likely the result of accidental injury to the ensiform or pubic bones.

In *normal ossification* we deal with an accumulation of lime salts within the stroma or cells of a tissue that has usually undergone certain preparatory changes in the way of formation of more or less homogeneous ground substance but has not suffered a total loss of vitality, though the vitality is possibly decreased.

Pathologic calcification is similar insofar as we have to deal with deposition or partial loss of vitality and which very frequently are hyaline.

Ossification is accomplished only in varieties of connective tissue, but calcification may involve any sort of cell or tissue provided it is degenerated sufficiently. Finally, it should be stressed that any area of calcification is likely to be replaced by bone.

SUMMARY

- (1) Various factors contributing to calcification in the soft tissues are discussed.
- (2) Illustrations are submitted to show the wide range of possible anatomic sites that may be involved.
- (3) There is abundant evidence of calcification occurring in normal and pathological tissues which is frequently of importance from a radiological point of view.

BIBLIOGRAPHY

- (1) ORTON G. HARRISON. Calcium Changes and Their Importance in Diagnostic Radiology (Mackenzie Davidson Memorial Lecture). *British Jour Radiol* February 1936 9, 102-125.
- (2) CANTAROW A. Review of Phosphatase Activity and Calcium and Electrolyte Metabolism. *Internat Clinics Ser 46* March 1936 1, 230-273.
- (3) BARR D. P. Pathological Calcification. *Physiological Reviews* 1932 12, 593-824.
- (4) WELLS H. G. *Chemical Pathology*. Fifth Ed., W. B. Saunders & Co. 1925.
- (5) The Vitamins. A Symposium of the Present Status of the Knowledge of Vitamins. Reprinted from *Jour Am Med Assn Am Med Assn Chicago* 1932.
- (6) BLUNT K. and COWAN R. Ultra violet Light and Vitamin D in Nutrition. University of Chicago Press 1930.
- (7) SHELLING D. H. and HOPPER K. B. Calcium and Phosphorus Studies Six Years Clinical Experience with Viosterol in the Prevention and Treatment of Rickets Tetany and Allied Diseases. *Bull Johns Hopkins Hosp* March 1936 58, 137-211.

TABLE V —RELATION BETWEEN TUMOR DOSE AND RADIATION EFFECT

X-rays

Tumor Dose (T E D)	Total No Cases	Radiation Effect					
		R E 0		R E 1 and 2		R E 3 and 4	
		No	Per Cent	No	Per Cent	No	Per Cent
Less Than 2	9	6	67	0	0	3	33
2-4	68	29	43	18	26	21	31
4-6	45	16	36	8	27	21	47
More Than 6	16	3	18	2	13	11	69
Radium							
Less Than 1	8	2	25	5	63	1	12
1-2	46	21	46	7	15	18	39
2-3	9	2	22	2	22	5	56

More accurate data for comparison than the clinical regression are to be found in the relationship existing between the microscopic radiation effect and the calculated effective dose (T E D) delivered. For example, in Table V we see that in the x-ray group, the percentage of R E B 0 cases falls (67 per cent-18 per cent) as the calculated tumor dose increases. At the same time, the percentage of R E B 3 and R E B 4 cases rises (33 per cent-69 per cent) as the tumor dose increases. Such data confirm the usual statement that *the larger the minimum dose delivered to the tumor, the more likely is its radiation effect to fall in the higher groups*. It might be pointed out that doses in excess of 6 T E D are desirable, since 69 per cent of the cases receiving this dose showed a radiation effect of R E B 3 or R E B 4.

It is obvious that in any particular case there is a definite relationship between the amount of radiation falling on the skin and the amount of effective radiation reaching the tumor. It would seem apparent that the larger the skin dose, the larger will be the effective radiation dose received by the tumor. But, since the tumors are situated at different depths, this does not always hold true, and it must be pointed out that expressions of dosage per skin portal are insufficient for clinical reports. Reference to any set of depth dose curves will make this point obvious. Attention has already been called to the

fact that a tumor situated close to the skin surface can receive a larger effective tumor dose from a comparatively small dose on the skin than a tumor much more deeply placed and receiving a much larger dose on the skin.

In Table VI we have tabulated the cases according to the dose of radiation falling on the skin, with their calculated minimum effective tumor dose. In the x-ray group the majority of the cases received greater than 1,800 r per skin portal, in the radium

TABLE VI —RELATION BETWEEN SKIN DOSE AND TUMOR DOSE

X rays

Skin Dose in r	Total No Cases	Minimum Tumor Dose in Terms of T E D			
		Less Than 4 T E D		Greater Than 4 T E D	
		No	Per Cent	No	Per Cent
Less Than 1 800 r	62	48	78	14	22
More Than 1 800 r	76	25	33	51	67
Radium Pack					
Less Than 25 000 mg hr	44	18	1	26	59
More Than 25 000 mg hr	19	6	32	13	68

ROENTGEN THERAPY OF DUPUYTREN'S CONTRACTURE¹

By S R BEATTY, M D, *Madison, Wis*

Senior Resident in Radiology, University of Wisconsin Medical School

DUPUYTREN'S contracture is the term applied to a flexion deformity of the hands caused by thickening and shortening of the palmar fascia. It was first described by the French surgeon, Dupuytren, in 1832. Infrequently this condition is found in the feet.

A definite etiologic factor has not been determined. Trauma, infection, plumbism, and heredity are all factors that have been considered, but as brought out by Meyerding (2) in his series of 273 cases and by many others, none of these is present in a predominant number of cases. The hereditary factor is accepted as being important by most of those who have studied these cases. Trauma is not accepted as being other than a possible predisposing factor. The incidence is relatively low, even an approximate figure being difficult to estimate, but the condition is not rare, as several authors report rather large series of cases.

The pathology is that of a gradually developing contracture of the palmar fascia with increasing flexion deformity of the fingers and palms, usually starting as a nodule at the base of the ring finger and increasing to involve all or part of the palmar fascia and its extensions. The tendon sheaths are not intrinsically involved. The fibrous tissue becomes increased and compact, and lymphocytic infiltration is frequently present.

The condition is usually progressive, tending to involve the entire fascia and produce crippling flexion deformities of the fingers. Occasionally a case becomes stationary. The diagnosis is made on the presence of thickened nodules in the palms at the base of the fingers or from the characteristic flexion deformities of the more advanced cases.

The usual treatment is surgical, and the results, in the hands of a competent surgeon, may be excellent. The technic required is meticulous, requiring skillful dissection and careful preservation of the tendons, nerves, and vessels enmeshed in the tough fibers of the hypertrophied fascia.

The chief objections to surgery are the danger of infection, the possibility of injury to the small but important vessels and nerves, the prolonged period of immobilization in extension required, and the disinclination of many to submit to a rather serious operative procedure.

Little has been written concerning the radiologic treatment of Dupuytren's contracture. In an admittedly incomplete review of the literature but scanty reference to treatment of this condition by the roentgen ray has been found (3). A few papers on radium therapy have been published, but these are confined, as far as can be determined, to the European literature (1, 4).

A method of treatment involving none of the objections to surgical intervention previously mentioned, which can be carried out without loss of time, or the causing of pain or inconvenience to the patient, should, if results are at all comparable, be preferable to surgery. No large series of cases treated by roentgen therapy has been reported, so that statistical comparison is impossible. In any event, the undisturbed anatomy present after roentgen therapy permits the more radical procedure in the event of an unsuccessful result without considerable loss of time, and the fear of surgery frequently inclines the sufferer to years of procrastination while the disease progresses.

The technic of roentgen treatment used in this department is based on the administration of moderate doses of lightly filtered roentgen rays at weekly intervals.

¹ From the Department of Radiology and Physical Therapy, University of Wisconsin

TABLE V —RELATION BETWEEN TUMOR DOSE AND RADIATION EFFECT

X-rays							
Tumor Dose (T E D)	Total No Cases	Radiation Effect					
		R E 0		R E 1 and 2		R E 3 and 4	
		No	Per Cent	No	Per Cent	No	Per Cent
Less Than 2	9	6	67	0	0	3	33
2-4	68	29	43	18	26	21	31
4-6	45	16	36	8	27	21	47
More Than 6	16	3	18	2	13	11	69
Radium							
Less Than 1	8	2	25	5	63	1	12
1-2	46	21	46	7	15	18	39
2-3	9	2	22	2	22	5	56

More accurate data for comparison than the clinical regression are to be found in the relationship existing between the microscopic radiation effect and the calculated effective dose (T E D) delivered. For example, in Table V we see that in the x-ray group, the percentage of R E B 0 cases falls (67 per cent-18 per cent) as the calculated tumor dose increases. At the same time, the percentage of R E B 3 and R E B 4 cases rises (33 per cent-69 per cent) as the tumor dose increases. Such data confirm the usual statement that *the larger the minimum dose delivered to the tumor, the more likely is its radiation effect to fall in the higher groups*. It might be pointed out that doses in excess of 6 T E D are desirable, since 69 per cent of the cases receiving this dose showed a radiation effect of R E B 3 or R E B 4.

It is obvious that in any particular case there is a definite relationship between the amount of radiation falling on the skin and the amount of effective radiation reaching the tumor. It would seem apparent that the larger the skin dose, the larger will be the effective radiation dose received by the tumor. But, since the tumors are situated at different depths, this does not always hold true, and it must be pointed out that expressions of dosage per skin portal are insufficient for clinical reports. Reference to any set of depth dose curves will make this point obvious. Attention has already been called to the

fact that a tumor situated close to the skin surface can receive a larger effective tumor dose from a comparatively small dose on the skin than a tumor much more deeply placed and receiving a much larger dose on the skin.

In Table VI we have tabulated the cases according to the dose of radiation falling on the skin, with their calculated minimum effective tumor dose. In the x-ray group the majority of the cases received greater than 1,800 r per skin portal, in the radium

TABLE VI —RELATION BETWEEN SKIN DOSE AND TUMOR DOSE

X rays					
Skin Dose in r	Total No Cases	Minimum Tumor Dose in Terms of T E D			
		Less Than 4 T E D		Greater Than 4 T E D	
		No	Per Cent	No	Per Cent
Less Than 1,800 r	62	48	78	14	22
More Than 1,800 r	76	25	33	51	67
Radium Pack					
Less Than 25,000 mg hr	44	18	1	26	59
More Than 25,000 mg hr	19	6	32	13	68

therapy in skilled hands, the absence of pain, avoidance of hospitalization and interference with occupation, and the absence of contra-indications one should consider this method of treatment before resorting to the more radical surgical procedure. There are, undoubtedly, some cases which are not good subjects for roentgen therapy and which are more suitable for surgery to begin with. The indications should be carefully worked out

for each individual patient with close co-operation of the surgeon and radiologist.

REFERENCES

- (1) APERT, M. E. Retraction of Palmar Aponeurosis. Influence of Heredity. Beneficial Effect of Radium Emanation. *Bull de la Soc Méd des Hôpitaux de Paris*, 1925, 49, 1502-1505.
 - (2) MEYERDING, H. W. Dupuytren's Contracture. *Arch Surg*, February 1936, 32, 320-333.
 - (3) SOLOMON, I., BISSEON, A., and GIBERT, P. Roentgen Therapy of Dupuytren's Contracture. *Jour de Radiol*, 1925, 9, 476-478.
 - (4) SPECKLIN, P., and STOEHER, R. Retraction of the Palmar Aponeurosis with Neuralgia Cured by (Radium) Radiation. *Presse Méd*, 1922, 30, 743-745.
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with the group of small tumors a larger percentage of them received a large dose than received a small dose. The reverse of this condition is seen when large tumors are studied.

TABLE IX —RELATION BETWEEN T E D AND SIZE OF TUMOR

X rays					
Tumor Size	Total No Cases	Threshold Doses			
		Less Than 4 T E D		Greater Than 4 T E D	
		No	Per Cent	No	Per Cent
Small	59	27	46	32	54
Large	79	46	58	33	42
Radium					
Small	26	5	19	21	81
Large	37	19	51	18	49

A question arose as to whether the radiation effects observed might bear some *relationship to the age of the patient*. The ages varied from 30 to 78 years. However, the percentage of the young and old with radiosensitive tumors was approximately the same. Apparently the poor prognosis in cancer of the breast in young individuals is not due to differences in tumor radiosensitivity.

It has been argued by some that many of the cases showing advanced degrees of radiation effects might eventually go on to complete sterilization if not operated upon. In this group of cases the time interval between completion of treatment and the operation varied from 6 to 416 days. However, the percentage of cases falling into the various radiation effect groups did not vary widely in any of the groups, therefore the time element necessary for sterilization of the tumor seems to be of less importance than was anticipated.

In calculating these doses, no attention was paid to the time factor in irradiation time, or the accumulation effect. Since in either series all cases were treated in approximately the same time, they are directly comparable in themselves. How-

ever, before comparing the radium and x-ray results, it is necessary to consider the time factor. With the radium pack, the entire treatment to the primary lesion was administered in six days or less, to any one field in five days or less, and each individual dose was 90 per cent of the threshold dose. With the x-rays, the entire treatment consumed on an average of 21 days, and the dose to any given field usually about 18 days, each individual dose being about 60 per cent of the threshold.

One of us, with Dr. MacComb, has made an extensive study of the recuperation of human skin under roentgen and gamma radiation (see Fig. 1) or the accumulation of radiation effect therein (7 and 8). While our work was, of necessity, limited to mild reactions, it offers very suggestive information in irradiations of the type under consideration in this report. The figure shows the relative recuperation in the skin in any given field, from the two types of therapy used. The total cumulative dose from 24,000 mg-hr of gamma radiation is 1.6 threshold dose, that from 1,800 roentgens is 1.4 threshold dose. In other words, although the total dose from the radium was 2.7 threshold doses, and from the x-rays 3.6, actually because of the time factor (or the spreading out of the x-rays over many more days) the cumulative dose in the skin is 15 per cent more from the radium than from the x-rays. The clinical findings bear this out. No serious and permanent skin damage resulted from x-ray therapy, while this was not infrequently observed from radium.

With regard to accumulation in the tumor, no information is available. The whole underlying reason for divided doses rests on the assumption that recuperation is less in tumor cells than in normal ones. In this case, recuperation must be less in tumor cells than in the skin. Whether recovery from the effect of radium and of x-rays proceeds at the same rate is also unknown. In the skin the rate for radium is somewhat less than for x-rays, and the clinical impression is that this is also applicable to the tumor. In any case, it is

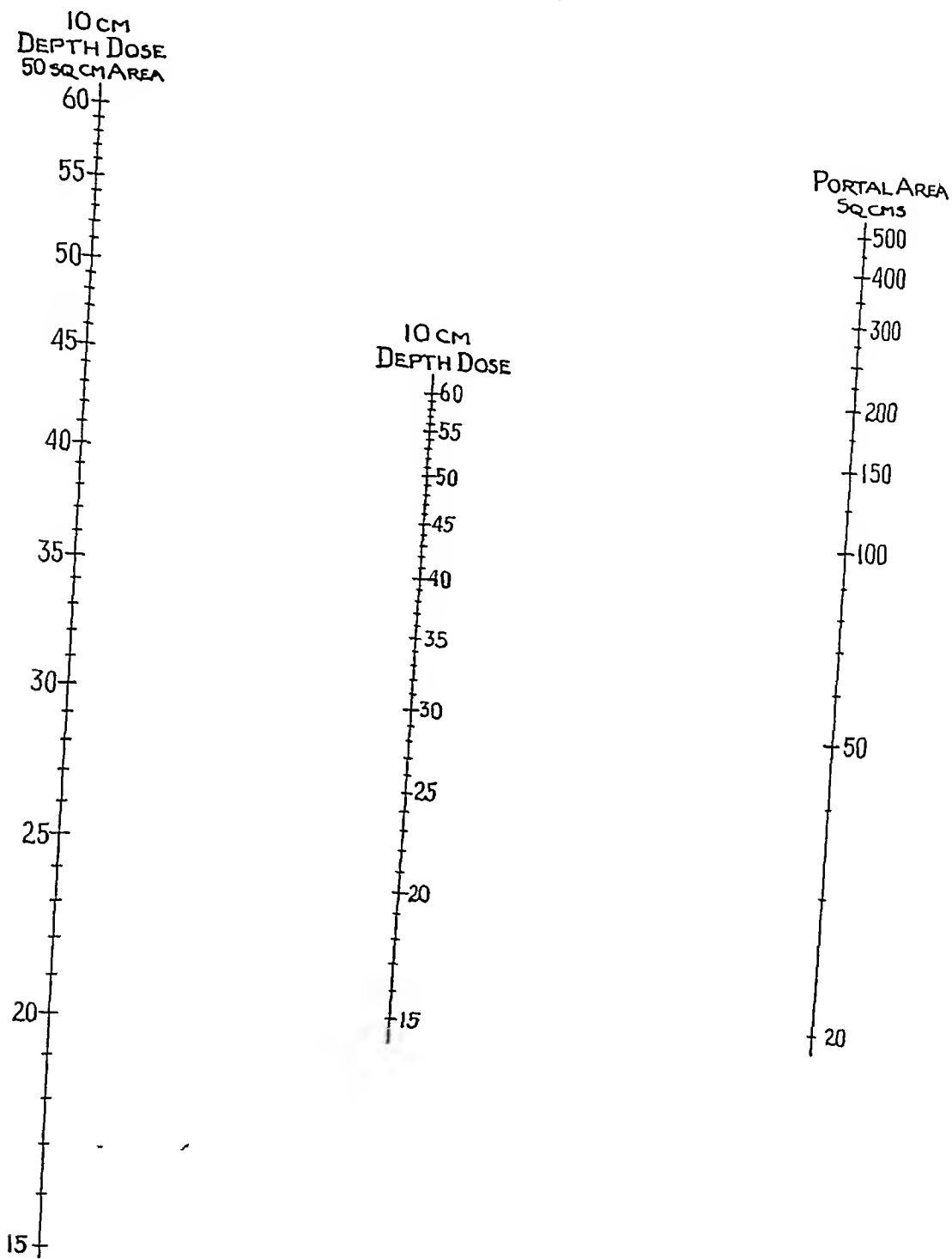


Fig 1 Nomogram for calculating 10 cm percentage depth doses under portals of different sizes *

*Copies of these charts 8 X 10 in in size, can be obtained for ten cents each in stamps from the Institute of Cancer Research Columbia University New York City

Before treatment was initiated, careful measurements had been made relating to the exact tumor size, thickness, depth, and position in the breast. With all the physical factors of radiation treatment at hand, a study was then made, correlating the tumor dose (T E D) with the resultant radiation effect in the tumor.

Differing radiation effects are grouped according to a scale of microscopic changes. In both the series treated by x-rays and that treated by the radium pack, certain facts were apparent.

1 The clinical impression as to the residual tumor can be fairly well relied on (71 per cent for x-ray cases and 75 per cent for radium pack cases) to express the radiation effect obtained.

2 The larger the minimum tissue dose delivered to the tumor, the more likely is a profound radiation effect to be obtained.

3 It is necessary to deliver by x-rays at least six threshold skin doses within three weeks, and with radium almost three threshold skin doses within six days to the deepest portion of the tumor, if the maximum radiation effects are to be obtained in 70 per cent and 56 per cent, respectively.

4 There is a definite relationship between the size of the tumor mass and the radiation effect obtained.

5 The chance of obtaining a high radiation effect decreases as the size of the tumor increases.

6 Since tumors vary enormously in size, as well as the *amount* of overlying tissue, it is evident that from the *same* beam of irradiation, very different doses may be delivered to the most deep-lying tumor cells. The inadequacy of expressing radiation dosage as a certain number of roentgens, or of milligram-hours per port, is evident.

7 The age of the patient and the differences in interval between completion of irradiation and operation had no apparent influence on the radiation effect observed in the tumor in this series of cases.

BIBLIOGRAPHY

- (1) ADAIR, FRANK E. To be published.
- (2) ADAIR F E and STEWART F W. *Ann Surg*, August, 1935, 102, 254-260.
- (3) ARNISON A N and QUIMBY, EDITH H. *RADIOLOGY* August 1935 25, 182-197.
- (4) MARTIN HAYES E, and QUIMBY, EDITH H. *Am Jour Roentgenol and Rad Ther*, February, 1930 13, 173-196.
- (5) PACK, GEORGE T, SCHARNAGEL, I M, QUIMBY, EDITH H, and LOIZEAUX M C. *Arch Surg* December 1935 31, 851-896.
- (6) LEE, B J, and PACK, GEORGE T. *Acta Radiol* 1931, 12, 416-454.
- (7) MACCOMB, W S and QUIMBY, EDITH H. *RADIOLOGY*, August, 1936, 27, 196-207.
- (8) QUIMBY, EDITH H and MACCOMB, W S. *RADIOLOGY*, September, 1937 29, 305-312.

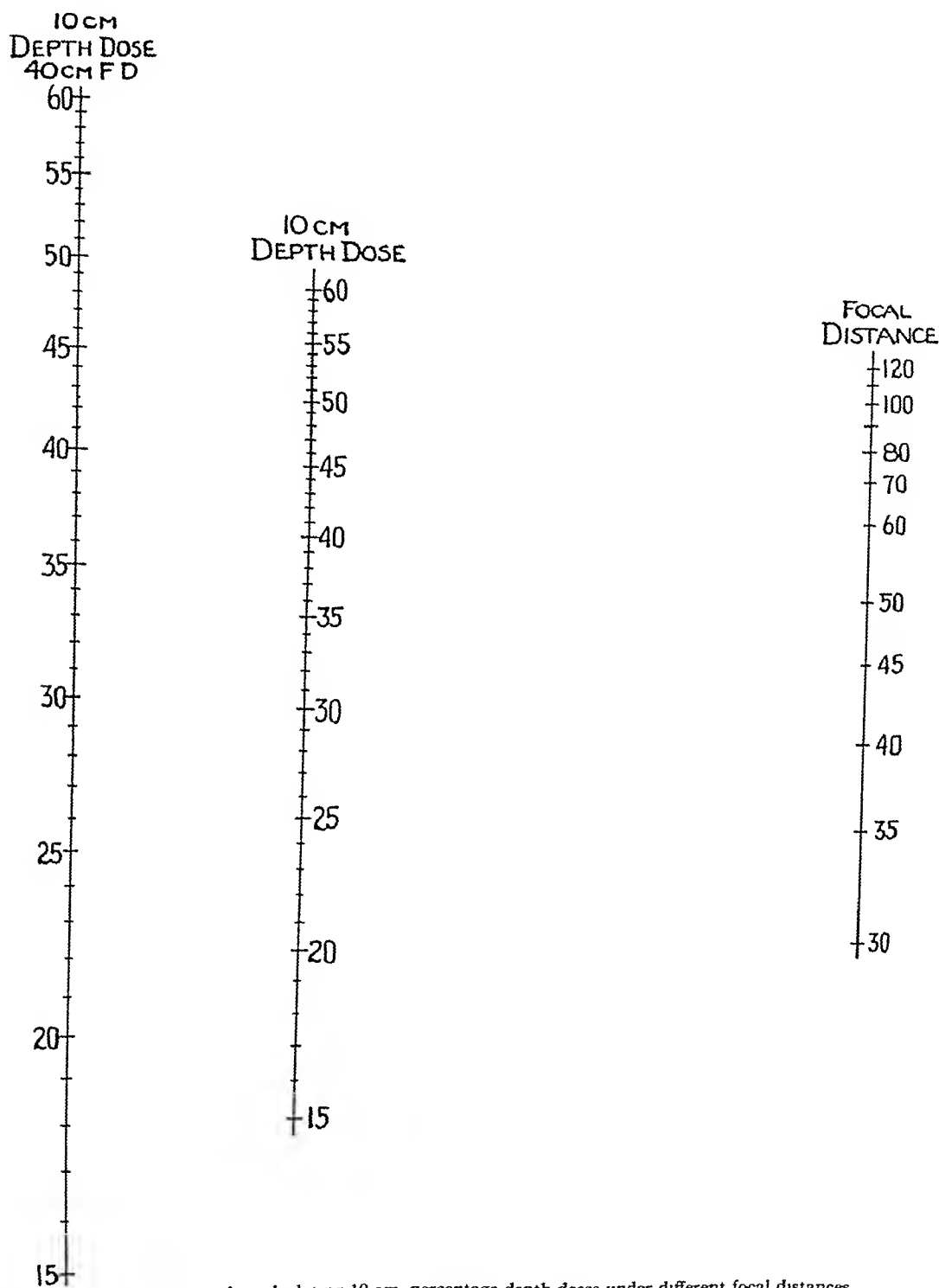


Fig 2 Nomogram for calculating 10 cm percentage depth doses under different focal distances

percentages of these This particular dis- because the majority of investigators have
tance was chosen as a basis for calculation used it in their measurements In Table



Fig 3



Fig 4



Fig 5

Fig 3 Discrete calcified shadows uniformly distributed throughout both lungs with an old healed lesion in the right apex. The calcified shadows represent healing of a miliary tuberculous dissemination in both lungs.

Fig 4 Two triangular calcified shadows in the region of the adrenals. Intravenous study shows both kidneys, well outlined, with slightly dilated pelves, but with normal calices. The calcified shadows are due to calcification occurring as a result of tuberculosis (Addison's disease).

Fig 5 Irregular calcified shadows surrounding the bodies of the first and second lumbar vertebrae, as a result of calcification in a cold abscess due to tuberculosis, the tuberculous process in the bodies of the vertebra having cleared up and the abscess entirely calcified.

If calcium is in excess, a certain amount forms the insoluble phosphate and a considerable amount is excreted as other salts.

The excretion of calcium occurs through the kidney and large bowel. So we see the formation of calculi due to excessive excretion of calcium, through the kidney, from over-absorption due, in turn, to acid bowel content. Again, renal calculi are observed in certain bedridden patients, in cases in which decalcification often is due to inactivity, leading to the abnormal excretion of calcium, with deposition. The calculi may disappear when the patient resumes active life.

(B) *Vitamin D*—Vitamin D is essential to normal calcium and phosphorus metabolism. It is indispensable for maintaining the normal calcium and phosphorus concentration and ratio in the blood and for the normal formation of bone. There is an increased net retention of calcium and phosphorus brought about through the resultant of two opposing factors: (1) The increased absorption from the diminished excretion into the intestines, (2) the increased elimination by the kidneys (5, 6, 7).

Hypervitaminosis D can cause widespread calcification in the arteries and possibly in other tissues (8). In children, we have seen hypervitaminosis D cause an unusually dense zone of calcification in the metaphyses of the long bones.

(C) *Parathormone*—The physiological effects of the parathyroid hormone have been briefly outlined by Aub (9):

- (1) To raise the blood calcium and lower the blood phosphorus
- (2) Possibly to increase the ionized calcium in the blood
- (3) To increase the calcium and phosphorus excretion in the urine
- (4) To obtain calcium for this increased demand either from a large amount of ingested calcium or from the stores in bones with the mechanism still not definite.

We have all seen the bone changes of hyperparathyroidism.

(D) *Other Ductless Gland Secretions*—The effect of some of the other ductless

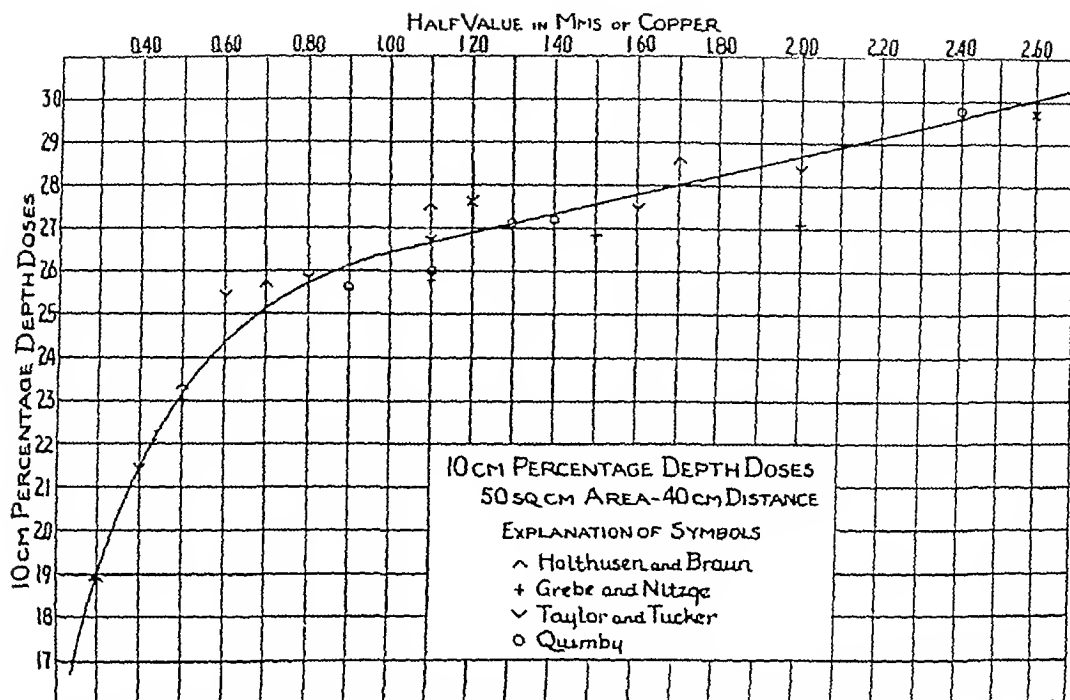


Fig 3 Chart shows 10 cm percentage depth doses under x-ray beams of different qualities, when the portal area is 50 sq cm and the focal distance 40 cm

the first or area nomogram is used. A line is passed from the point marked 200 on the right-hand scale, through the point marked 48 on the middle scale. This intersects the left-hand scale at approximately 35 per cent, which is the dose when the area is 50 sq cm and the distance 122 cm. To find the dose when the focal distance is 40 cm, the second or distance nomogram is employed. A line passing through the point marked 120 on the right-hand scale and that marked 35 (the value obtained in the first operation), intersects the left-hand scale at approximately 29 per cent. This, therefore, is the percentage depth dose when the half value of the beam is 2.6 mm of copper, the area 50 sq cm, and the distance, 40 cm. This value is entered in Table IV in the last column. When all of the data given by Mayneord and Roberts (4) are treated in this way, it is found that those relating to depth doses when the half value in copper is 2.6 are very much alike, the average being 29.7 per cent. Similarly, when the half value of the incident beam is 1.2 mm of copper, the percentage depth dose,

when the area of the portal is reduced to 50 sq cm and the distance to 40 cm, is found to be 27.6 per cent.

A large amount of data relating to percentage depth doses under beams of different qualities has been treated in this way. The results shown in Figure 3 were derived from measurements of four groups of investigators, each of whom obtained depth doses under several different qualities of radiation. Other data have been similarly analyzed but are not shown in the figure. The values obtained from Holthusen and Braun's extensive series are, in general, higher than the average, those of Grebe and Nitzge are lower. The differences are not large. The curve drawn to fit the various points must necessarily be a compromise. The maximum deviation from the curve is 1.4 per cent. The curve thus shows with fair precision the 10 cm percentage depth doses when the portal area is 50 sq cm and the distance 40 cm for all qualities of beams whose half values in copper lie between 0.30 and 2.6 mm. Or, expressed in other terms, for the range of qualities represented by 100 kv and



Fig 10 (above) The lower half of the spleen covered with an irregular mottled calcified shadow, the result of metastatic malignancy in the spleen the primary lesion being in the cardiac end of the stomach

Fig 11 (below) Large circular calcified shadow showing stippling in the center. Calcified fibro-adenoma of the uterus



Fig 12 (above) Large, solid ovoid tumor mass, uniform in outline, filling the entire pelvis (lithopedion) due to death and calcification of a fetus

Fig 13 (below) Dense irregular calcified shadows in a cystic goiter present for 20 years and recently undergoing malignant changes



served in exophthalmic goiter (10, 12), and calcium excretion is increased in exophthalmic goiter after administration of desiccated thyroid (9)

The thymus (13, 14) and the sex glands (15, 16, 17, 18) apparently take some part in calcium metabolism but the influence of the spleen, posterior lobe of the pituitary, and the adrenal gland is still not definitely established (2)

(E) *Hydrogen Ion Concentration*—The concentration of hydrogen ions in a given tissue may be an important factor controlling the deposition of calcium in that an alkaline reaction favors calcium deposition

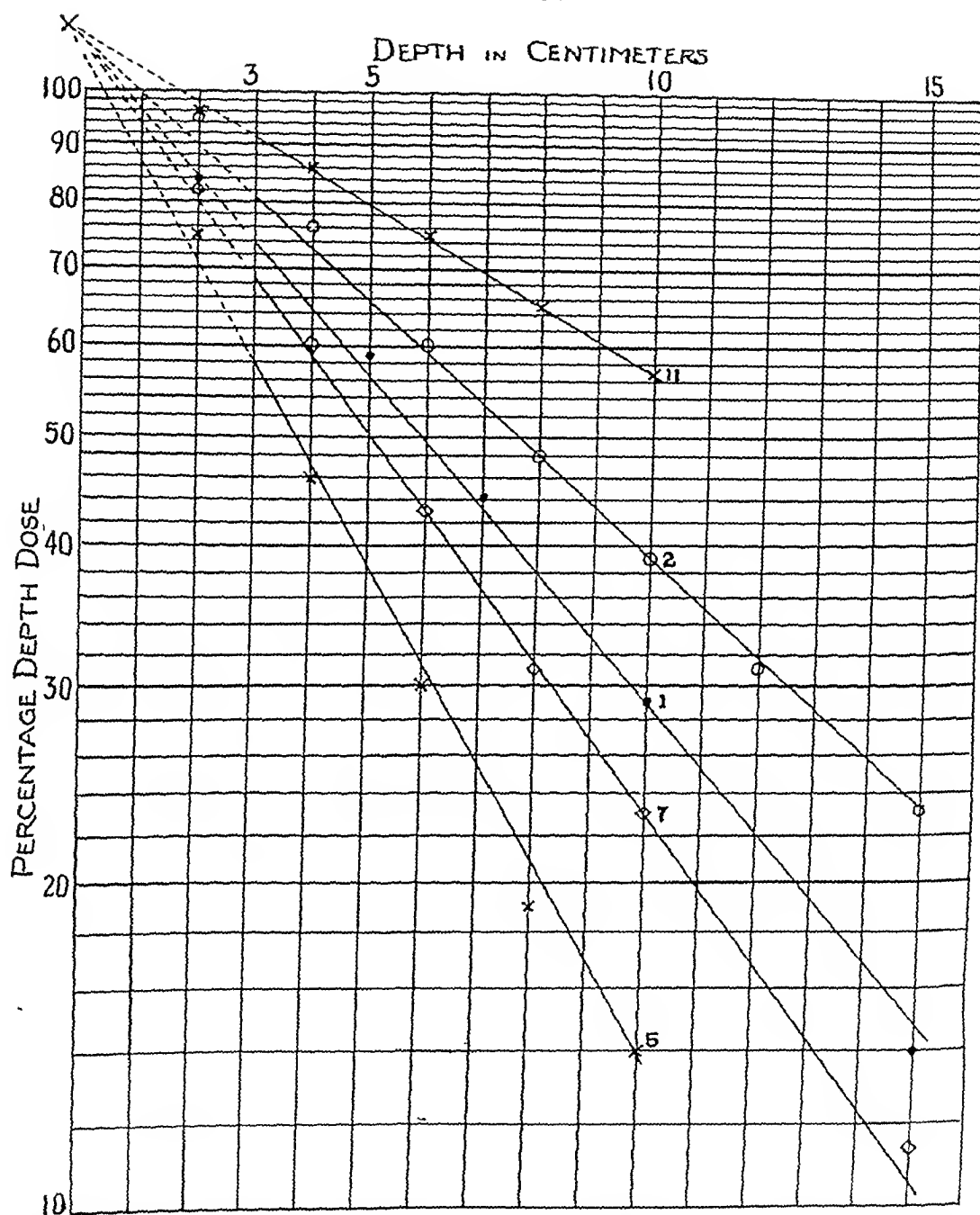


Fig 4 The logarithms of percentage depth doses when plotted against the depth in centimeters tend to fall along straight lines This figure can be used for determining depth doses at various levels if the 10 cm percentage depth dose is known For explanation see text

the points tend to fall along exponential curves, as shown are Figure 4 The experimental data are taken from various sources to illustrate the wide range of radiation conditions within which this ex-

ponential relationship is found The data for the curve marked 11 were obtained with the use of a beam of 1,000 kv (11), those for curve 5, from measurements made with a beam having a half value of 0.11

The experimental deposition of calcium by intravenous or intraperitoneal injection, at a distance from the site of introduction,

also given rise to calcium deposits (35, 36) In these last experiments, the distribution of the calcium is similar to that occurring



Fig 17

Fig 17 Irregular dense calcified shadow, 2 X 3 cm in diameter in the right frontal region due to a tuberculoma in the brain



Fig 18

Fig 18 Many nodular calcified shadows ranging from 3 mm to 1 cm in diameter, distributed in the brain. These shadows are present in the meninges and represent healed tuberculous lesions



Fig 19 A

Fig 19 A Postero-anterior view Extensive calcification in the aorta and a calcified oval shadow which is in the heart mass, above the diaphragm typifying calcification in the aortic ring



Fig 19-B

Fig 19 B Left oblique view Extensive calcification and tortuosity of the aorta and the calcified oval aortic ring in the posterior portion of the heart is shown to better advantage

has also been obtained (34) It has also been produced by the addition of acid to the diet, possibly by causing increased absorption of calcium. Experimental administration of parathyroid hormone and of toxic doses of irradiated ergosterol have

in disease, in cases in which the direct injection of calcium gives rise to an unusual distribution

DYSTROPHIC CALCIFICATION

When the organism has a portion of dead

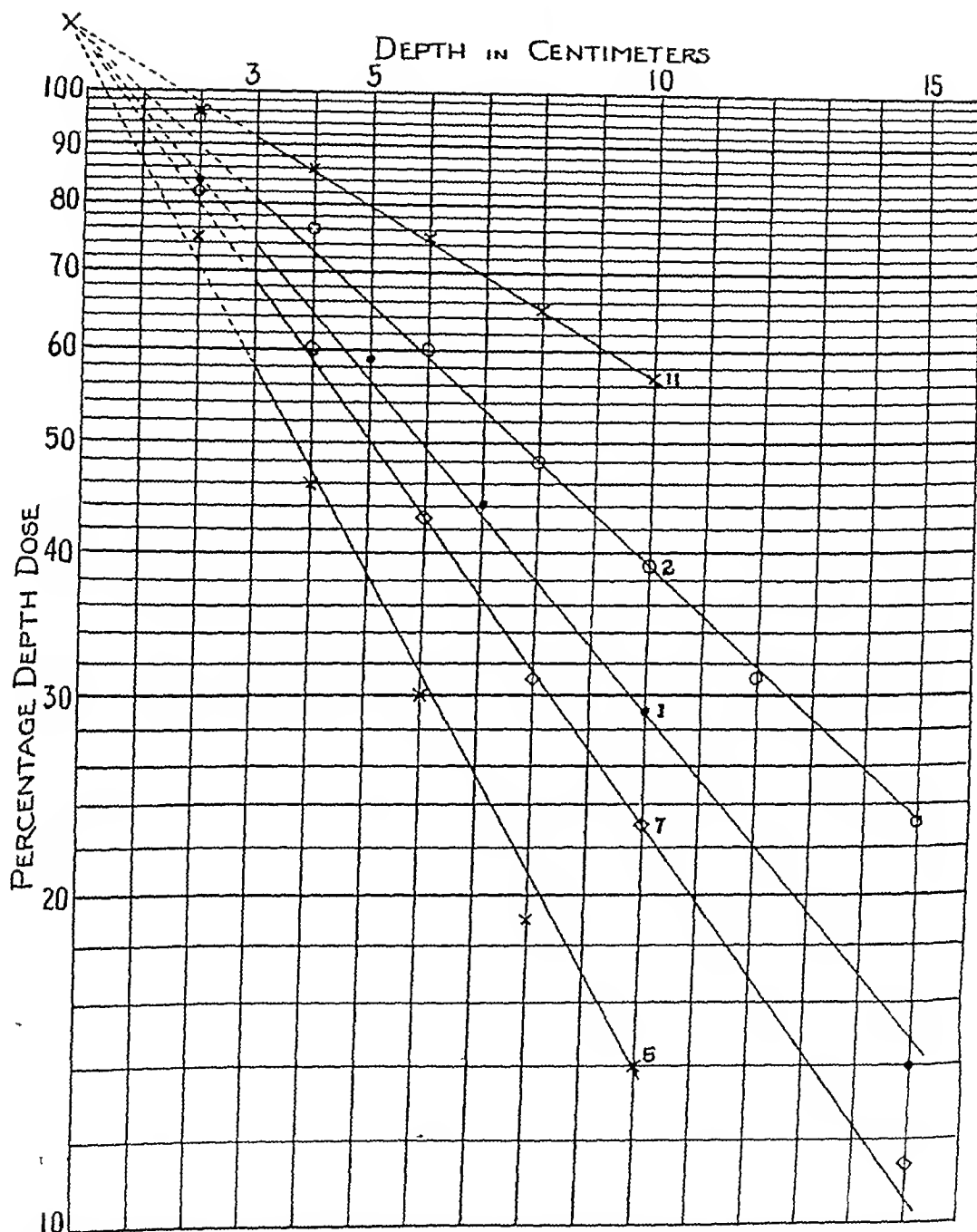


Fig 4 The logarithms of percentage depth doses when plotted against the depth in centimeters tend to fall along straight lines. This figure can be used for determining depth doses at various levels if the 10 cm percentage depth dose is known. For explanation see text.

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ponential relationship is found. The data for the curve marked 11 were obtained with the use of a beam of 1,000 kv (11), those for curve 5, from measurements made with a beam having a half value of 0.11

smaller than the *Cysticercus*, being usually the size of a grain of sand and is difficult to see with the naked eye

and in which they may present a serious diagnostic problem. The cranial cavity is such a structure (38). Normally, one

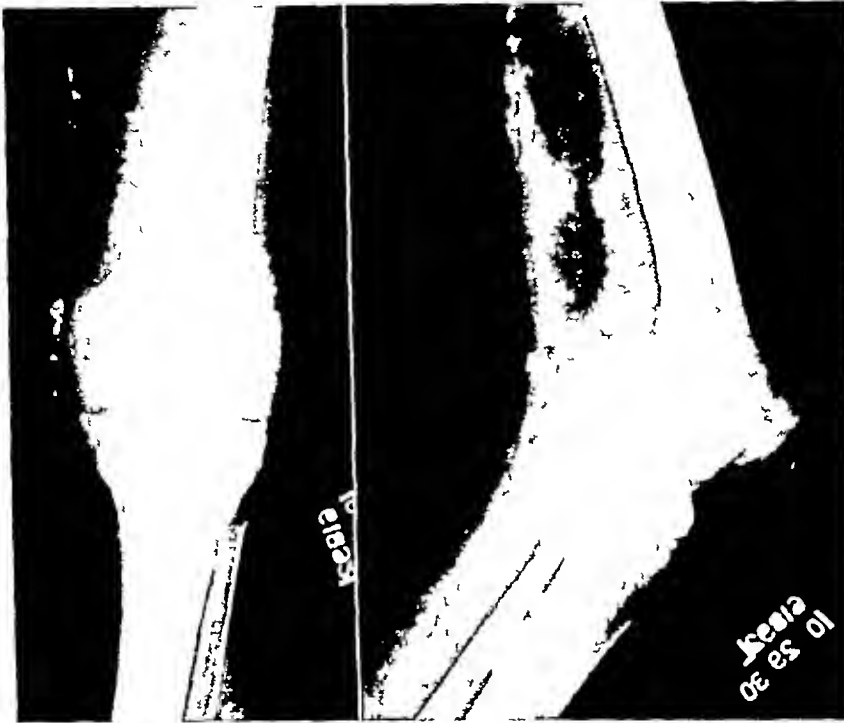


Fig 21-A

Fig 21-B

Figs 21-A and 21-B. Calcified long saphenous vein. The denser calcified shadows are in the valves of the veins and the calcification is not uniform, as in the arteries.

Calcification in tendons, particularly in the tendon of the supraspinatus muscle, and in the various bursæ, is a very frequent finding. In the shoulder, the calcium deposit is usually in the supraspinatus tendon and, due to its close proximity to the subacromial or subdeltoid bursa, the diagnosis of a calcified bursitis is usually made (37). The shadow may vary from a few millimeters to several centimeters in diameter. The amorphous carbonates and phosphates form a liquid mass between the fibers of the tendon with no capsule or limiting membrane.

A common site of ossification is in the achilles tendon, especially after injury. This is also seen in the joint capsules, particularly in the femur.

There are certain parts of the body in which calcified areas are commonly seen

may see calcification occurring in the pineal gland and choroid plexus, the falx cerebri, and in the tentorium, particularly about the sella turcica, especially in that portion connecting the posterior clinoids with the petrous ridges. Usually, calcification in any other area within the skull suggests a tumor. Rarely, tuberculosis (Fig 17) as a single lesion or even multiple tuberculomas (Fig 18) may be noted. The pineal gland is calcified in approximately 50 per cent of cases. Calcification occurs less frequently in the choroid plexus than it does in the pineal gland. A similar punctate type of calcification occurs in psammomas but the opacities in psammomas are larger and more numerous and the situation is different. The calcifications in the falx are most often seen as oblong or irregular opacities; they are never round and there

THE IMPORTANCE OF STATEMENT OF TUMOR DOSE IN RADIOTHERAPY¹

By JOHN R. NUTTALL, M.D., D.M.R., *Manchester, England*

ONE feels constrained to apologize for the introduction of this somewhat unscientific—I was almost going to say “appeal”—among a series of scientific papers. May I offer as excuse my own difficulties as a beginner in radiotherapy, and my conviction that just as it was necessary to have a universal unit of dosage, so it is becoming important that the many radiotherapeutic clinics in the world should mean one and the same thing when they state dosage.

At the present time there are many different methods in common use of describing dosage. For example, in some clinics the total number of roentgens given to all the skin fields is stated. Other clinics use the even looser form of merely stating the kv, ma, number of fields, and total time of irradiation to a field. Doses are described as measured “in air” in one center, and as “with back-scatter” in another. In radium work, statement of the total milligram-hours is still widely accepted as being a description of dosage, although a slight increase in radium-lesion distance, or of treated area may double them. Statement of dose to tumor is used in still other clinics.

This confusion of expression makes exact appreciation of an author's technique very difficult from reading his articles or hearing his dissertations, and, because of this, hinders the progress of a branch of medicine which is sufficiently tied to the mathematical science of physics to be potentially a fairly exact science itself. It appears particularly unfortunate that no standard method of statement of dosage is in use when it is borne in mind that already an internationally accepted unit of dosage is available for x-ray work, and when there is every reason to believe that

doses of x- and gamma-rays can both be measured in terms of roentgens. Furthermore, unlike most other therapeutic agents whose dosage is of necessity described as being the amount given to whole-body exposure *via* the gastro-intestinal tract, hypodermically, or intravenously, irradiation dosage can be stated in terms of the amount delivered to the actual part under treatment.

The patient, after all, presents himself at a clinic for the treatment of his tumor. However the individual radiotherapist may approach the problem of the treatment of his patient, fundamentally he sets out to deliver a dose of irradiation which will be lethal to the tumor, and to deliver it in a manner as little harmful as possible to the surrounding normal tissues. It would appear reasonable, therefore, for him to think and speak and write in terms of the dosage it is necessary for him to give to the tumor he is treating, rather than in terms of that given to the normal tissue which he would prefer entirely to avoid irradiating were it possible for him to do so.

Exact knowledge of tumor radiosensitivity is directly dependent upon knowledge of the response of tumors of similar histology to known doses of irradiation. The most obvious way of obtaining information of radiosensitivity is the examination of the results of all the ordinary clinical treatments carried out in as many clinics as possible. This appears to be the only means of reviewing a sufficiently large number of cases to afford reliable data. Statement of tumor dose as the salient item on the routine treatment record sheets is necessary if the material is to be usable for scientific observation of this kind.

Advances in radiotherapeutic technique are the result of experiments carried out because the therapist is dissatisfied with his present work, and believes he can prove

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept 13-17 1937



Fig 23-A

Fig 23 B

Fig 24

Fig 23 A Calcinosis universalis Irregular calcified areas in the fascia muscles, and subcutaneous tissues of the thigh separated from the bone and running parallel to the soft structures of the leg

Fig 23 B Irregular calcification in the fascia and muscles around the elbow and arms

Fig 24 Myositis ossificans showing layers of ossified bone in the muscles of the left lower leg separated from the shaft but running parallel to it

the aorta, especially in the region of the knob, and in the lower abdominal portion. These plaques are a very common finding in the lower extremities, particularly in diabetic patients. The walls of aneurysms (Fig 20, A and B) very frequently show calcification in the sac. Phleboliths frequently form in the pelvis (Fig 21), with the veins showing a solid ossification with rounded dense areas near the valves.

CALCINOSIS

Calcinosis may be defined as the abnormal deposition of calcium salts in the skin, subcutaneous tissues, muscles, and the tendons of the body (41). It may be subdivided into two general groups—calcinosis circumscripta and calcinosis universalis. In calcinosis circumscripta (Fig 22), the calcific deposits are primarily limited to the extremities and their deposition is frequently symmetrical. The deposits of calcium are often found around the joints. The condition is most prevalent in persons in the second half of life. In calcinosis uni-

versalis, there is a tendency for widespread multiple calcareous deposits not only in the skin but in the deeper structures (subcutaneous tissues, muscles, and tendons) especially in the region around the joints. Calcinosis universalis (Fig 23) is observed in patients in the younger age groups, most frequently in the first two decades of life. The pathogenesis is as yet undertermined. The blood calcium in practically every case of both types has been normal. The condition may be related to dermatomyositis and scleroderma. Roentgen examination may make the diagnosis in cases in which nodules are not palpable by physical examination and this point cannot be stressed too strongly.

MYOSITIS OSSIFICANS

When ossification occurs in the soft tissues, particularly in muscles, it is usually termed "myositis ossificans." There are four types of myositis described (42, 43): (1) progressive, (2) myositis circumscripta, (3) localized myositis (Fig 24), with ossi-

field is entered upon this after every treatment. In a conspicuous position, in a contrasting color of ink, so that it immediately catches the doctor's eye each time the patient attends for follow-up examination, is a statement of

Method	{ Radium X-ray	Tumor dose
Over-all time		Skin doses

This is the only information about dosage copied on to the analysis cards of the statistical department.

It is very necessary for rapid advance in radiotherapeutic science that both the routine and experimental work of all centers should be readily comparable. To achieve ready comparability it would appear that, however much detail may be given, simple statement of two things is essential: (1) The result of the irradiation (was the lesion cured, or was it not?), (2) how much irradiation had to be given to achieve that result (what was the tumor dose?).

There are, of course, many technical difficulties in the realization of a universal standard description of dosage, quite apart from those directly related to differing personal opinions. In X-ray therapy the depth dose phantom charts greatly sim-

plify matters. Similar data are available in the use of the radium "bomb." It is, however, essential that the beams from each port of entry shall in fact cross in the tumor for summation of the depth doses to give the tumor dose. Correction for lessened density due to the large amount of air must be made in intrathoracic radiotherapy. When radium is used in the form of multiple sources, either interstitially or on applicators, the physical distribution of the sources must be such as to give homogeneity at the level of the lesion. A reasonable assessment of tumor dose can, however, be stated in any treatment carried out in conformity with modern physical conceptions of radiotherapy, and it is better to make a reasonable or approximate assessment in cases in which the physical difficulties are great than not to attempt ever to state the dose at all.

A plea is, therefore, made for the practice of stating tumor dose as the salient statement in describing radiotherapeutic technique, on the following grounds:

- (1) This dose is the basic criterion of any treatment.
- (2) It is essential for accurate knowledge of radiosensitivity.
- (3) It would simplify the teaching of radiotherapy.
- (4) It would greatly aid correlation of the results obtained in various clinics.

gen und Kalkmetastasen in den Nieren Virch Arch , 1881, 83, 508

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(34) TANAKA, M Ueber Kalkresorption und Verkalkung Biochem Ztschr , 1911, 35, 113

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(36) HEUPER, W Metastatic Calcifications in Organs of a Dog after Injection of Parathyroid Extract Arch Path , 1927 3, 14

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(38) O SULLIVAN, J Some Rarer Intracranial Calcifications and Ossifications British Jour Radiol , August 1925, 30, 295-304

(39) CAMP J D Roentgenologic Manifestations of Intracranial Disease RADIOLOGY, December, 1929, 13, 484-493

(40) BISHOP, P A, and ROESLER, H Roentgenologic Diagnosis of Intracardiac Calcifications Am Jour Roentgenol and Rad Ther , January 1934, 31, 1-15

(41) STEINITZ, H Calcinosis Circumscripta ('Kalkgicht ') and Calcinosis Universalis Klin Wchnschr June 13, 1931 10, 1132-1135

(42) MAGRUDER, L F Myositis Ossificans Progressiva Am Jour Roentgenol and Rad Ther , April, 1926 15, 328

(43) MAKINS G Discussion on Myositis Ossificans Traumatica British Jour Radiol September, 1924 29, 323-334

tance for various types of tubes as they are affected by the angle of the target face

The apparatus described consists of a simple wood-constructed tube holder for the roentgen tube with a special accurately

distance is set by the apparatus. Card-board film holders are used. Enlargements may be made by increasing the distance to the film. Under no circumstances may the kilovolt peak be increased above 40, as the danger of spark-over through the lead grid is imminent.

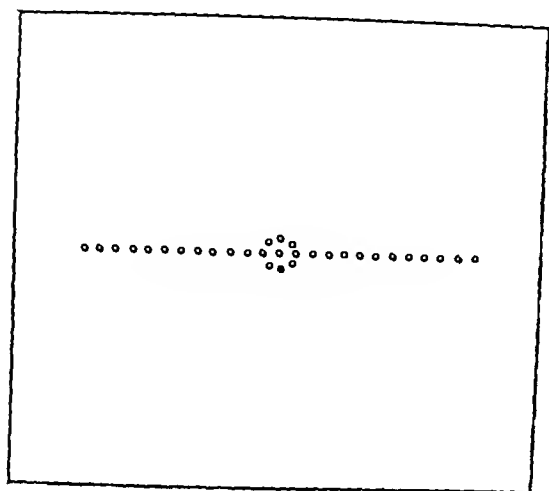


Fig 1-B

perforated lead diaphragm placed on an arc between the tube and a film which is to be exposed for record (Fig 1-A)

It is also possible to study the lateral divergence by use of grids constructed in that plane. It is conceivable that many methods of grid construction may be applied to the basic apparatus in the future. The grid shown is the best found as yet for comparison studies, as it is possible to obtain several exposures on the same film.

The tube is enervated from a regular x-ray machine in the usual manner.

The arc of the film and of the lead diaphragm is so constructed that the appearance of the film exposed is the same as the composite image obtained by many horizontally placed films exposed with the target placed at various angles. The saving in film for experimental purposes in this procedure is obvious.

It is recommended that the following technic be used in making the records described: kv p, 40, ma, 10, sec. 10. The distance of the target to the lead grid is not to exceed 4 inches, the usual film

DESCRIPTIVE DATA

- 1 Westinghouse Treatment Tube, tungsten disc (Fig 1)
 Dark ring— Actual focal spot
 Lighter halo— Margin of focal spot
 Wide halo— Outside edge of entire anode
- 2 Universal Broad Focus, solid tungsten anode (Fig 2)
 Dark center— A crater on surface
 Light ring— Flat surface
 Dappled outer dark ring— Melted raised areas on target
 Outer halo— Outer margin of anode
- 3 Universal Medium Focus, solid tungsten anode good condition (Fig 3)
 Dark— Actual focal spot
 Halo— Anode
- 4 Universal Fine Focus, solid tungsten anode good condition (Fig 4)
 Dark— Actual focal spot
 Halo— Anode
- 5 So-called Self-rectified Tube, 5-10, solid copper anode containing a tungsten button good condition (Fig 5)
 Dark spot— Tungsten focal spot
 Halo— Copper anode
- 6 Gas Tube (over 30 years old) (Fig 6)
 Appears to be platinum face and copper back. The density of this spot is not the same as of the other tubes due to the drop in kv p caused by the amount of resistance in the circuit
- 7 X-P 1 Small side (Fig 7)
 X-P 1-4 General Electric Double Focus Tube (Line Focus)

- (8) HAM A W, and LEWIS, M D Experimental Intimal Sclerosis of Coronary Arteries of Rats Arch Path March, 1934, 17, 358-361
 - (9) AUB J C, BAUER W, HEATH, C and ROPES, M Studies of Calcium and Phosphorus Metabolism III—The Effect of Thyroid Hormone and Thyroid Disease Jour Clin Investigation, April 1929 7, 97-127
 - (10) PARTON, M L influence de la thyroïde sur le métabolisme du Calcium Comptes Rend Soc Biol, 1912, 230, 620
 - (11) BERNHARD Aber ein Fal Von Osteomalazie," München med Wchnschr, 1927, 74, 432
 - (12) PLUMMER W and DUNLAP, H F Cases Showing Osteoporosis Due to Decalcification on Exophthalmic Goiter Proc Staff Meet Mayo Clinic, 1928, 3, 119
 - (13) HARRIS, L J An Apparent Role for the Thymus (in Calcium Metabolism) Nature, 1930, 126, 346
 - (14) ROWNTREE L G, CLARK, J H, and HANSON, A M Biologic Effects of Thymus Extract (Hanson), Accruing Acceleration in Growth and Development in Successive Generations of Rats under Continuous Treatment with Thymic Extract Jour Am Med Assn Nov 10 1934, 103, 1425-1430
 - (15) MIRVISH, L and BOSMAN, L P The Influence of Internal Secretions of Ovary on the Calcium in Blood Level and on Calcium Metabolism
 - (16) Idem The Effect of Ovarian Extracts on the Calcium Blood Level in Man Quart Jour Exp Physiol, 1927 18, 29
 - (17) Idem The Effects of Testicular Extracts on the Blood Calcium British Jour Exp Biophys 1929 6, 355
 - (18) REISS M and MARX, K Ovarialhormon und Blutkalk Ekörperchen Hormons Endokrinologie March, 1928 1, 181-184
 - (19) STIEGLITZ E J Histologic Hydrogen-ion Studies of Kidney Arch Int Med April 1924, 33, 483-496
 - (20) KAY, H D Phosphatase in Growth and Disease of Bone Physiol Rev July, 1932 12, 384-422
 - (21) LERICHE, and POLICARD La Physiologie Normale et Pathologique de l'Os Paris 1926
 - (22) VIRCHOW R Kalkmetastasen Virchow's Arch, 1855, 8, 103
 - (23) ASKANAZY M Beitrage zur Knochenpathologie Festaschr f Jaffe Braunschweig 1901
 - (24) LAZARUS P and DAVIDSOHN C Hirnhautsarkom mit zahlreichen Kalkmetastasen im Herzen Ztschr f klin Med 1906 9 314
 - (25) LITTEN M Ueber pathologische Verkalkun
-

13 Is a defective tube split target which was replaced by manufacturer upon the strength of this picture (Fig 13)

CONCLUSIONS

1 A device is presented for experimental investigation of roentgen-ray tube targets

2 It is hoped that the low cost of this device will permit its adoption in many clinics, and as a consequence of its use many previously unknown facts may be brought to light

3 Some of the results obtained with this device are demonstrated

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(37) CODMAN, E A Abduction of Shoulder Subacromial Bursitis Boston Med and Surg Jour , June 13, 1912, 166, 890

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This accounts for the increase in depth dose with increasing size field. It similarly plays an important rôle in skin dosage because the back-scatter increases the amount of radiation being received by the skin by just that amount which is being scattered back to the skin from the underlying tissues.

Most measurements, as made in the United States, are made in free air. This means that the ionization chamber which absorbs the radiation being measured is placed sufficiently far distant from any solid body so that no back-scatter reaches it. Obviously, if we so measure, we do not have a true indication of the amount of radiation which the skin is receiving. The skin is receiving, in addition to what we measure, the amount due to back-scatter. This amount is dependent upon the quality of the radiation and upon the size of field being radiated. In view of this, why do we not at all times measure with back-scatter, that is, with the ionization chamber on the surface of the body, instead of in air? In the first place, from a strictly scientific point of view, the definition of the International Roentgen definitely excludes scattered radiation. Secondly, there are certain inherent technical difficulties in measuring with back-scatter which render determinations, as made by the average radiologist in his own x-ray department, subject to rather serious experimental errors. For example, the precise position of the ionization chamber in respect to the skin surface plays an important part in the readings. A chamber placed on the skin will register considerably different from one half-buried in the skin (as it should be). It has been the author's practice to make all measurements in free air, and then to calculate from these the tissue dose on the skin which includes the sum of the incident and the back-scattered radiation. Back-scatter determinations were made once, under carefully controlled conditions, and from these data the calculations are made. In this way, the errors of measurements made under practical laboratory conditions are elimi-

nated. All measurements were made with a thimble type ionization chamber. While these measurements are subject to the errors described by Qumby before a previous International Congress, they are made on the same basis as most other measurements in this country and so can at least be used for comparative evaluations. The back-scatter data which the author uses are shown in the following table.

TABLE I

Field Size	Wave length	Percentage Back-scatter			
		0.15	0.25	0.40	0.80
25 sq. cm		16	13	6	2.5
100 sq. cm		30	23	13	7.0
200 sq. cm		38	27	16	8.0
300 sq. cm		43	30	18	8.5
400 sq. cm		45	32	20	9.0

This table shows an interesting sidelight on the effect of back-scatter from a practical clinical side. In deep therapy the field size is usually large, seldom less than 15×15 cm. From the table it may be seen that there is relatively little change in back-scatter with different large size fields. On the other hand, in skin or superficial therapy in cases in which there are large differences in field size used, the total amount of back-scatter is small with any size field. Thus, once a proper technique is established, it is almost unnecessary to make allowances for different size fields, as any errors are almost automatically eliminated by the manner in which x-ray therapy is administered.

However, in estimating depth dose, the relation of scatter to air measurements must be fully understood in order for one not to be misled in regard to the tissue dosage being given. All depth dose measurements must be made inherently with back-scatter. The ionization chamber is first half embedded into the surface of the phantom for surface readings, and then totally into the phantom for depth readings at the required depth. Under these conditions the measurements necessarily include back-scatter. Ordinary clinical dosage measurements are made in air, and it has been my experience that many

- (8) HAM, A W, and LEWIS, M D Experimental Intimal Sclerosis of Coronary Arteries of Rats Arch Path, March, 1934, 17, 356-361
- (9) AUB, J C, BAUER, W, HEATH C, and ROPES, M Studies of Calcium and Phosphorus Metabolism III—The Effect of Thyroid Hormone and Thyroid Disease Jour Clin Investigation, April, 1929 7, 97-137
- (10) PARTON, M L enfluence de lat thyroide sur le metabolisme du Calcium Comptes Rend Soc Biol, 1912, 230, 620
- (11) BERNHARD Aber einin Fal Von Osteomalazie " München med Wchnschr, 1927, 74, 432
- (12) PLUMMER W and DUNLAP, H F Cases Showing Osteoporosis Due to Decalcification on Exophthalmic Goiter Proc Staff Meet, Mayo Clinic, 1928 3, 119
- (13) HARRIS, L J An Apparent Rôle for the Thymus (in Calcium Metabolism) Nature, 1930, 126, 346
- (14) ROWNTREE, L G, CLARK, J H, and HANSON A M Biologic Effects of Thymus Extract (Hanson), Accruing Acceleration in Growth and Development in Successive Generations of Rats under Continuous Treatment with Thymic Extract Jour Am Med Assn, Nov 10, 1934 103, 1425-1430
- (15) MIRVISH, L and BOSMAN, L P The Influence of Internal Secretions of Ovary on the Calcium in Blood Level and on Calcium Metabolism
- (16) Idem The Effect of Ovarian Extracts on the Calcium Blood Level in Man. Quart Jour Exp Physiol 1927 18, 29
- (17) Idem The Effects of Testicular Extracts on the Blood Calcium British Jour Exp Biophys, 1929, 6, 355
- (18) REISS M, and MARX K Ovarialhormon und Blutkalk Ekörperchen Hormons Endokrinologie March, 1928, 1, 181-184
- (19) STIEGLITZ E J Histologic Hydrogen ion Studies of Kidney Arch Int Med April, 1924 33, 483-496
- (20) KAY H D Phosphatase, in Growth and Disease of Bone Physiol Rev July 1932, 12, 384-422
- (21) LERICHE, and POLICARD La Physiologie Normale et Pathologique de l'Os Paris 1926
- (22) VIRCHOW R Kalkmetastasen Virchow's Arch, 1855, 8, 103
- (23) ASKANAZI M Beitrage zur Knochenpathologie Festaschr f Jaffe Braunschweig 1901
- (24) LAZARUS P and DAVIDSOHN, C Hirnhautsarkom mit zahlreichen Kalkmetastasen im Herzen Ztschr f Klin Med 1906 9, 314
- (25) LITTEN, M Ueber pathologische Verkalkun-

200 kv p, it is essential that all measurements be made on the basis of surface readings, or at least, if made in air, be properly correlated to surface readings. Certainly, the radiologist must become more constantly cognizant of the inter-relationship between the dose as measured and administered under air beam control, and the dose as delivered to skin and to tissues within the body

TABLE I

Case	History	Lesion	Treatment	Result
G W, age 72, white, typesetter heredity, no	Contracture as result of infection of hands and forearms	Contraction of fascia to third and fourth fingers of right hand and fifth finger of left	11-2-34 to 11-13-35, 9 treatments	Right middle finger much improved, right fourth no improvement, left fifth improved
M B R, age 65, white, lawyer	Appearance of swelling and nodule in right palm six months before first treatment	Firm nodule in palm right hand	11-23-31 to 2-22-37, 31 treatments to various fields	Improvement of primary contractures, pain eliminated new nodules were resolved as they appeared
Mrs J R age (?), white housewife		Nodule in center of right palm 1 cm diameter hard and movable	5-29-34 to 1-29-35, 6 treatments	Marked reduction in size of nodule
O S, age 66 white, physician heredity no	Nodule appeared 15 years ago Operated on 1929-1930 Ankylosis left hand	Contracture of entire palm of left hand and along fourth metatarsal to finger	6-5-33 and 6-14-33, 2 treatments	No change—no return
J R C age 78 white, univ professor heredity no	No previous operation	Marked contracture of third and fourth fingers Vesicular eruption in palm of right hand	9-5-30 to 10-7-30, 5 treatments	No change in contracture, eruption cleared, loss of pain At present slowly increasing contracture
J E, age 44, white, heredity no	Thickening noted for four years in left palm two months in right	Marked contracture of left palm over third and fourth tendon sheaths about 3 X 4 cm Nodule in right palm 1 X 2 cm	11-4-32 and 11-12-32 2 treatments	Lost—did not return
L B, age 46 white, heredity no	Cut left wrist in 1906 Operation in 1927 relieved patient for two years Notes now increased contracture and pain	Right third and fourth fingers markedly contracted second less so, left third and fourth fingers contracted less Unable to close left hand	8-19-30 to 3-3-31, 8 treatments	Relief of pain without much change in the contracture
W H N age 52 white heredity no	Contractures appeared three years before admission	Heavy fibrous contractures of right fourth and left fourth and fifth fingers	5-14-35 to 11-25-35, 11 treatments	Marked improvement in contractures
N M, age 48 white, laborer brother has same condition one hand	Onset since 1928	Fascia of third and fourth fingers of left hand third fourth and fifth fingers of right hand indurated and contracted	12-2-36 to 8-25-37 6 treatments	Fingers of left hand can be extended completely Result good but less marked in right hand No pain
A R age 57 white heredity no	Slowly progressive contracture since 1921	Contracture of ring and middle fingers of both hands	8-26-36 to 9-9-36, 3 treatments	No improvement

For technic see text

for three to four weeks. Several such series may be given at intervals of from six to eight weeks as progress indicates. The technical factors used are 100 kv, 5 ma, 30 cm FSD, filtration of 1 mm to 2 mm Al (HVL in Cu = 0.11 to 0.14 mm), single doses of from 100 to 200 r (in air), being varied with the thickness and size of the contracture.

We have had the opportunity to observe and treat ten cases of Dupuytren's con-

tracture since 1928, and a summary of our findings is compiled in Table I. Its study shows that in seven out of ten cases treated there was improvement, with loss of pain, reduction of palmar nodes, and relief of contracture. In one or two cases with advanced contracture, the relief of contracture was marked.

It is not our purpose to discourage surgical treatment, but it seems to us that because of the lack of risk of roentgen

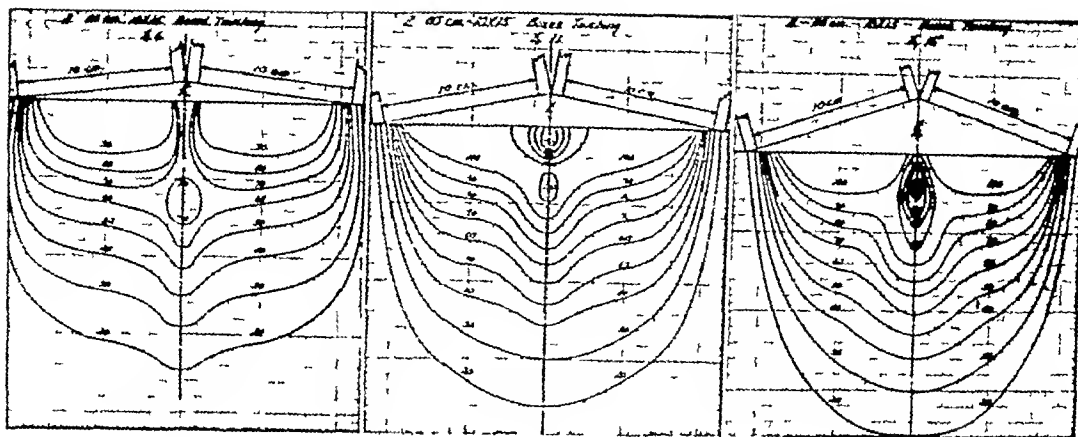


Fig 1

Fig 2

Fig 3

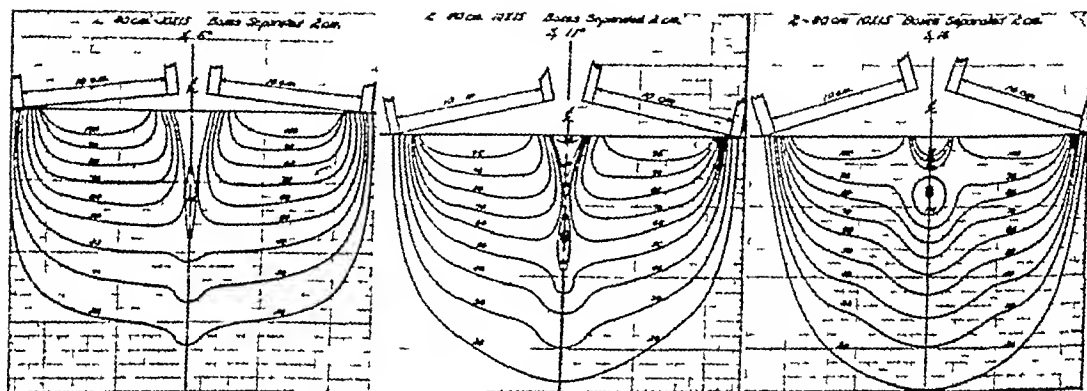


Fig 4

Fig 5

Fig 6

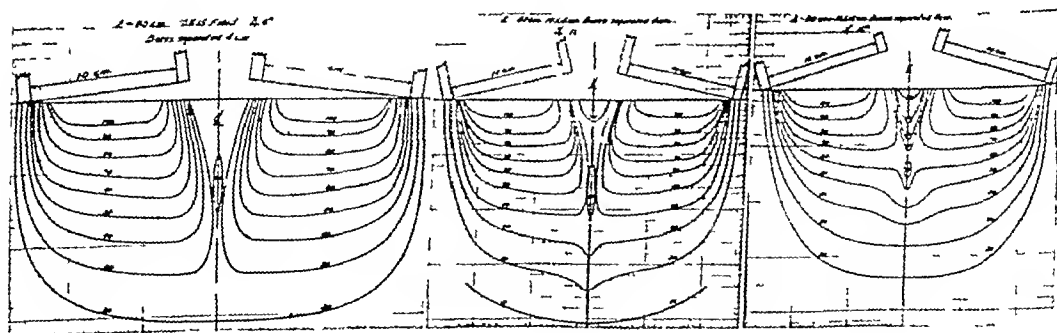


Fig 7

Fig 8

Fig 9

levels. The phantom was supported on a track, so that it could be moved horizontally in two directions by means of racks and pinions. A thimble type ionization chamber was used in conjunction with a Victoreen condenser meter. The

intensity was measured at centimeter intervals below the surface, along the center line and at lateral distances of 1, 2, 3, etc centimeters to the right (or left) of the center line. The values so obtained were related to the 100 per cent intensity on the

THE CALCULATION OF PERCENTAGE DEPTH DOSES

By CHARLES PACKARD, *New York City*

From Columbia University, Institute of Cancer Research, F C Wood, M D , Director

AN analysis of percentage depth dose data reveals some simple numerical relationships which exist between the magnitude of this dose and the size of the portal, the focal distance, and the half value in copper of the incident beam. These relations can be put to practical use in the calculation of approximate doses under widely different conditions of radiation.

The percentage depth dose is found by dividing the intensity measured at a depth by that measured at the surface. The latter consists of the intensity of the beam in air plus that of the back-scattered radiation. These terms are illustrated in Table I by two examples taken from Grebe and Nitzge's tables. In the first

which it is derived. In the following discussion only percentage depth doses at a depth of 10 cm will be considered.

I—THE EFFECT OF PORTAL AREA ON THE 10 CM PERCENTAGE DEPTH DOSE

The magnitude of the 10 cm percentage depth dose increases in a definite way with increasing portal areas. The most convenient method of showing this is to compare the magnitudes of doses found under different areas with that obtained under a portal of 50 sq cm. In Table II are given the results of an analysis of data obtained

TABLE II—THE RELATIVE MAGNITUDES OF 10 CM PERCENTAGE DEPTH DOSES UNDER DIFFERENT PORTAL AREAS, COMPARED WITH THE DOSE UNDER A 50 SQ CM PORTAL

	Area of Portal in sq cm					
	50	100	150	200	300	400
Holthusen and Braun (3)	100	117	130	138		159
Parker and Honeyburne (7)	100		132		150	
Mayneord and Roberts (4)	100	115		130		
Grebe and Nitzge (2)	100	119	129	137		170
Quimby and Copeland (10)	100	117		131		141
Average	100	118	130	136	150	160

NOTE: The averages here shown are obtained from all of the available data, of which the above are examples.

TABLE I
(From Grebe and Nitzge)

H V L	Area	Distance	Surface Int	Actual Int at 10 cm	Percentage Depth Dose
2 00	50 sq cm	50 cm	118%	34%	29%
0 25	400 sq cm	40 cm	136%	39%	29%

example, the surface intensity amounts to 118 per cent (the intensity of the incident beam is called 100 per cent, to this is added back-scattered radiation, which in this case amounts to 18 per cent). The actual intensity at 10 cm depth is 34 per cent of that of the incident beam. The percentage depth dose is, therefore, $\frac{34}{118}$ or 29 per cent. In the second example, the percentage depth dose is the same as in the first, but the actual depth and surface intensities are not. It is apparent that the percentage depth dose gives no information as to the actual values of these factors from

from various sources. In each case the value of the dose for the 50 sq cm area is made unity, and the doses obtained under larger portals are expressed as percentages of the first. Space does not permit the presentation of all of the data,¹ in the table only the averages derived from many ob-

¹ Complete data referred to in this paper may be consulted at the Crocker Laboratory.

APPLICATION OF ROENTGEN RAY IN DIAGNOSIS OF CONDITIONS OF THE THYMUS GLAND IN CHILDREN¹

By HERBERT A. JUDSON, M.D., *Los Angeles, California*

From the Department of Radiology, Los Angeles County Hospital

FOR practical purposes, the conditions of the thymus gland in children which require consideration are (1) Enlargement or hyperplasia. It has been felt for many years that the thymus, resting in close apposition to the trachea and great vessels and nerves at the point where they come through the rigid bony superior thoracic inlet, may, by its enlarge-

where asphyxiation and death may result (2) The condition of status thymico-lymphaticus, described as a combination of constitutional hereditary anomalies which includes preservation or hyperplasia of the thymus, hyperplasia of the lymphoid tissue of the intestines, spleen and elsewhere, with hypoplasia of the aorta and cardiovascular system and of the adrenals. Such

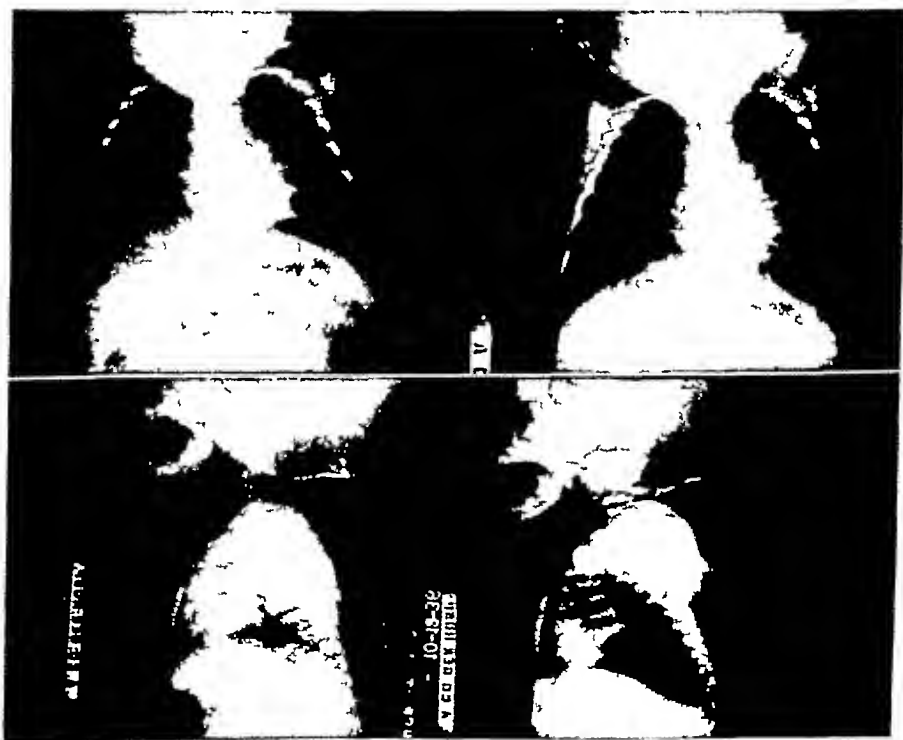


Fig 1 Normal appearance of the chest (see text). Upper views taken in the supine position at the left in expiration at the right in inspiration. Lower views taken in the lateral position, at the left in expiration at the right in inspiration.

ment, so compress these important structures as to produce obstructive symptoms such as dyspnea, stridor, coughing or choking, and cyanosis, at times to the point

individuals may suddenly die from the most trivial causes, and it has been thought that the finding of a large thymus may be a direct indication that this diathesis exists. Others believe that this condition may exist without obvious enlargement of the thymus.

¹ Much of the material presented is used through the courtesy of Dr. Oscar Reiss, Chairman of the Department of Pediatrics, Los Angeles County Hospital.

servations are given. In these sets of measurements the focal distances range from 30 to 120 cm, and the half values of the incident beams, from 0.30 to 5.2 mm of copper. It will be seen that the ratios set down under each portal area agree among themselves fairly well, except those for the largest portal. Here the values given by Grebe and Nitzge are uniformly much larger than any of the others. Those of Qumby and her collaborators are lower than the average. The averaged values of all of the available data are given on the lowest line of Table II. When these are plotted against the logarithms of the areas, they are found to lie along an exponential curve. From this it is possible to determine with reasonable accuracy how much greater or less than the dose under the 50 sq cm portal, will be the doses under portals of other sizes.

The nomogram (Fig. 1) simplifies this calculation. With its aid one can readily determine the 10 cm percentage depth dose under any area, if the dose under a 50 sq cm area is known. In making such a calculation it is assumed that the other radiation factors, that is, the focal distance and the quality of beam, remain unchanged. On the left-hand scale are given 10 cm percentage depth doses under a portal of 50 sq cm. On the right hand scale are shown various portal sizes from 20 to 500 sq cm. A line passing through the known depth dose value under the 50 sq cm portal, and a point on the right-hand scale which marks the area under which the depth dose is to be found, intersects the middle scale at a point which

gives the approximate depth dose value for that portal area.

For example, suppose that the percentage depth dose under the 50 sq cm portal is known to be 30 per cent, what will be the dose under a 400 sq cm portal? The line between the two points mentioned intersects the middle scale at 47 per cent. This, therefore, is the dose under the larger portal. Under a 100 sq cm portal the dose will be 36 per cent.

If the depth dose is known for some area other than 50 sq cm, the doses under larger and smaller areas can readily be found. If, for example, the dose under a 100 sq cm portal is known to be 30 per cent, and the dose under a 200 sq cm portal is desired (the other radiation conditions remaining the same), the procedure is as follows: a line is passed through the point marked 100 sq cm on the right-hand scale and the point marked 30 per cent on the middle scale. This intersects the left-hand scale at 25.2 per cent, which, therefore, is the dose under a 50 sq cm portal. Knowing this, the dose under the larger portal may be obtained in the manner first described. It is found to be 35 per cent.

II—THE EFFECT OF FOCAL DISTANCE ON THE 10 CM PERCENTAGE DEPTH DOSE

Data showing the effect of focal distance on the 10 cm percentage depth dose have been treated in the same way as those relating to the effect of different portal areas. The values for this dose, when the distance is 40 cm, are taken as unity, and those for other distances are expressed as

TABLE III—THE RELATIVE MAGNITUDES OF THE 10 CM PERCENTAGE DEPTH DOSE UNDER DIFFERENT FOCAL DISTANCES, COMPARED WITH THE DOSE AT 40 CM

	Focal Distance						
	30	40	50	60	75	80	100
Holthusen and Braun (3)	92	100	107	111	115		
Parker (6)		100		112		116	119
Parker and Honeyburne (7)		100		108		113	115
Grebe and Nitzge (2)	90	100	107	115			
Qumby (inverse square law) (8)	88	100	108	114	122	123	129
Average	91	100	107	111	115	115	118



Fig 3 Large thymus, slightly squared key-stone shape, 4.5 cm wide three times the width of the thoracic vertebra. Right lobe a little larger than the left. Trachea in the midline. (This film used through the courtesy of M. L. Pendell, M.D., Los Angeles.)

the trachea. There may be slight buckling or narrowing of the trachea, but no definite constriction or collapse.

Thymic Enlargement—Upon what basis should the thymus be called "enlarged," or said to be producing pressure? Wasson (1) says twice the diameter of the vertebra at the second or third interspace is a thymus of moderate size, three or more times the diameter is a large thymus.

Friedman (2) considers the normal upper mediastinal shadow as 3.5 cm in width in children under three. However, there is such wide variation that it is difficult to give definite measurements. Thus Kinney and Taylor (3), in a study of 160 consecutive infants, roentgenographed within 24 hours of birth, found no normal thymus shadow as to size, shape, or density. 54 were less than 3 cm in width at the level of the third dorsal vertebra, 36 were 3 cm, and 70 over 3 cm.

Pancoast (4) stresses the importance of a lateral view, placing particular signifi-

cance upon collapse or buckling of the trachea at the thoracic inlet in deep inspiration.

Both Pancoast and Hasley (5) emphasize the value of thorough fluoroscopic examination in all positions before a positive diagnosis of enlargement can be made. Figures 2 and 3 are examples of a definitely enlarged thymus.

Differential Diagnosis—Accurate uniform radiographic technic is essential to avoid mistaken diagnoses. Thus, incorrect position may so distort the shadows as to give a spurious appearance of enlargement of the thymus or of buckling of the trachea. This is illustrated in Figure 4, in which partial rotation of the patient in the lateral view has distorted the outline of the trachea.

The mediastinal structures in infancy and childhood are not fixed but move freely, changing size, shape, and position constantly during the respiratory and cardiac cycles. Figure 5 shows to what extent the respiratory phase may modify the picture and lead to a faulty impression of enlarged thymus.

In films which are correctly taken during inspiration, the widening of the superior mediastinal shadow is nearly always due to the thymus, especially in the very young. Tumors, causing enlargement, are very rare and are usually found in older children. An intrathoracic thyroid causes a mediastinal widening, but this is usually broad above and narrow below. It may be unilateral and it is almost always seen in adolescents and adults. Tuberculous adenitis also occurs in children, but gives a shadow usually denser and wider at the roots of the lungs. Figure 6 is an example of this disease.

Far more important and difficult than the conclusion as to whether or not a thymus is enlarged is the clinical application of the roentgen findings of a large thymus. In any given case in which a large thymus has been demonstrated, is this large thymus the cause of all or part of the child's symptoms or, if a large thymus is found

III are given samples of the data. The averages given at the bottom of the table are derived from all of the available data, and, therefore, differ somewhat from those which might be obtained from averaging the figures here presented. It is clear that the ratios are not as consistent as those found in the analysis of results on the effect of area on the depth dose. They differ from the latter also in that they do not fall along an exponential curve. Quimby (8) finds that the increase in the magnitude of the dose with increasing focal distance follows the inverse square law. Grebe and Nitzge's figures conform more or less to this rule, but the extensive data of Parker (6), Parker and Honeyburne (7), and Holthusen and Braun (3) do not, except when the area is small. According to the latter authorities, "the percentage depth dose increases with increasing focal distance more slowly than the inverse square law requires."

Figure 2 is a nomogram based on the data given in Table III. It is used in the same way as the first. The left-hand scale shows percentage depth doses at a focal distance of 40 cm. On the right-hand scale are marked various focal distances from 30 to 120 cm. If the depth dose is known when the distance is 40 cm, doses at greater or smaller distances can be determined by passing a line from the known value on the left-hand scale to a point on the right-hand scale marked for the distance at which the depth dose is to be found. The desired dose is seen on the middle scale at the point where the line intersects it. If the percentage depth dose for some distance other than 40 cm is known, the doses at any of the distances marked on the right-hand scale can be found by using the method explained in connection with the first nomogram.

III—THE EFFECT OF THE QUALITY OF RADIATION ON THE 10 CM PERCENTAGE DEPTH DOSE

The quality of an x-ray beam is usually described in terms of the thickness of a copper sheet which will reduce the radia-

tion to one-half of its original intensity.² In the numerous investigations on the effect of different qualities of radiation on the percentage depth dose, the experimental conditions have varied so widely that a direct comparison of results has not always been possible. The portal areas employed have ranged from 20 to 500 sq cm, the distances, from 30 to 120 cm. However, all of these data can be reduced, by means of the nomograms, so as to show what the approximate depth doses would be if the area in each case had been 50 sq cm and the distance, 40 cm. To illustrate the method of calculation, the following example is offered. In Table IV it is seen

TABLE IV—TO ILLUSTRATE THE METHOD WHEREBY PERCENTAGE DEPTH DOSES OBTAINED UNDER DIFFERENT QUALITIES OF RADIATION, AREAS, AND DISTANCES MAY BE COMPARED (*Data from Mayneord and Roberts, 4*)

H V L	Area	Distance	10 cm % Depth Dose	Depth Dose at 50 cm ² and 40 cm Distance	
2 6	50	75	35	30 8	
2 6	100	75	40	29 4	
2 6	200	75	47	29 6	
2 6	200	122	48	28 9	29 7% ave
1 2	50	75	32	27 9	
1 2	100	75	38	27 9	
1 2	200	75	43	27 2	
1 2	50	122	34	28 3	
1 2	200	122	44	26 5	27 6% ave

that when the half value of the beam is 2.6 mm of copper, the area 200 sq cm, and the distance 122 cm, the 10 cm percentage depth dose is 48 per cent. To find the dose when the area is 50 sq cm,

² The half value layer of the beam may be found in this way. The x-rays after passing through the filter are cut down to a narrow beam by a diaphragm. The dosimeter is placed from 15 to 20 cm below this. The initial intensity is then found. Next a sheet of 0.25 mm copper is added to the filter and the intensity again measured. This operation is repeated until the intensity has been reduced to less than half of its original value. The logarithms of the intensities are now plotted against the thickness of copper. Semi log paper is useful for this. The points which are plotted tend to fall along a straight line. By interpolation, the thickness of copper which reduces the beam to one half of its initial intensity can be found. This thickness is the half value in copper of the beam.



Fig 6 Tuberculous adenitis simulating thymic enlargement. The film on the left shows widening of the superior mediastinal shadow. The film on the right, taken four years later, shows calcification in this region, proving the process to be tuberculous. (These films used through the courtesy of M. L. Pindell, M.D., Los Angeles.)

the more recent literature, toward an increasingly doubtful attitude as to the significance of the thymus than that which prevailed a few years ago. Young and Turnbull (6), reporting for the Status Lymphaticus Investigation Committee of Great Britain, concluded "The facts elicited in the present inquiry afford no evidence that so-called 'Status Thymico-lymphaticus' has any existence as a pathological entity."

Hudson (7), presenting information from the Children's Hospital in Boston, states that Dr. J. P. Mahoney analyzed the data from the records of 16,195 children anesthetized between Jan. 1, 1930, and Sept. 1, 1934. There were 225 deaths (1.4 per cent) and autopsies were obtained in 70 per cent. He was unable to find a death which could be attributed to the thymus. Hudson concludes, "The evidence does not support the contention that the thymus may be a cause of sudden death in infants and children."

Kennedy and New (8), reporting admissions at the Mayo Clinic extending over a period of ten years, found no death which was attributable to hypertrophy of the thymus, either spontaneously or during or following anesthesia, in a large number of surgical procedures among the newborn

and older infants. They conclude that enlargement of the thymus can seldom, if ever, be established as a cause of death.

J. L. Morse (9) says, "There is no proof that the enlargement of the thymus is a primary or causative factor in the pathologic complex described as status lymphaticus."

Wasson (10) has emphasized how infection of sinuses and bronchi produces symptoms which may simulate the stridor, diagnosed as that of enlarged thymus.

Abt (11), of Chicago, in speaking of stridor in children, says, "I do not believe there is any evidence during life or post-mortem to show that the thymus enlargement causes enough compression of the trachea, bronchi, or larynx to produce stridor. Every other possibility should be excluded before a diagnosis of stridor due to enlargement of the thymus is made."

Waldbott (12) has shown that a large proportion of cases presenting so-called thymic symptoms have definite allergy, and believes thymic death may be the result of a primary anaphylactic edema of the lungs, with ensuing asphyxiation.

However, there are many others, such as Douglas Symmers (13), with his wide experience in Bellevue Hospital, and Gilkey (14), who find positive evidence of the re-

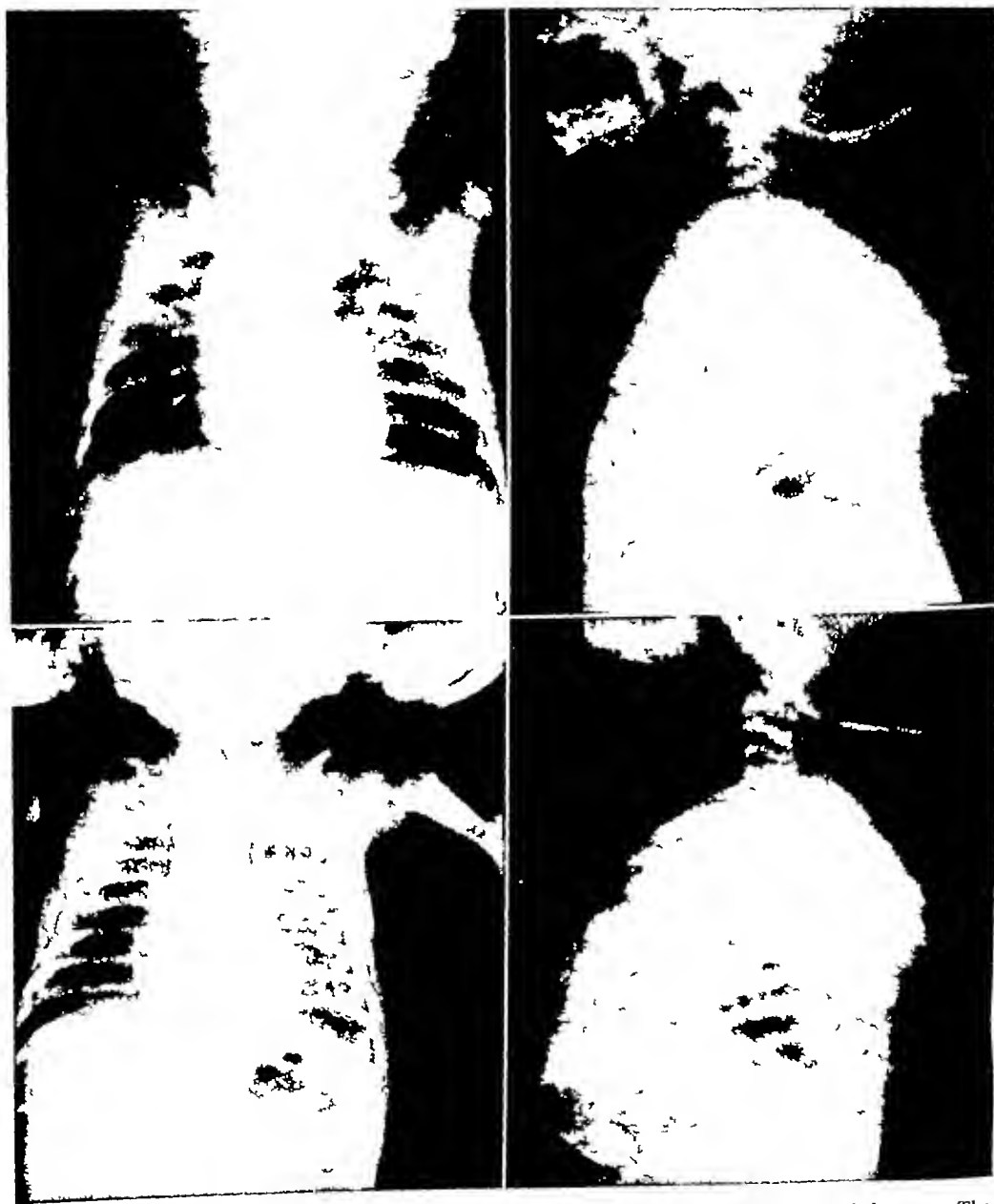


Fig 7 (*above*) Case 1 Retropharyngeal abscess with suspicion of associated enlarged thymus The symptoms subsided with incision and drainage of the abscess

Fig 8 (*below*) Case 2 Normal chest films Roentgen treatment given as a therapeutic test without improvement Later laryngoscopic examination revealed congenital laryngeal stridor

which substitution therapy with injection of thymus extract is employed, will be followed with interest. The function of the gland is still incompletely understood and there is a growing feeling that caution should be exercised in exposing an infant's thymus to the roentgen ray.

CONCLUSIONS

It is evident from the material presented that roentgen diagnosis of thymic enlargement is difficult and requires meticulous care in the examination, due to the ease and frequency with which change in position, varying respiratory phase, and

mm of copper (5) The areas and distances also vary widely

The straight lines in the figure converge toward a focus which lies somewhat above the 100 per cent point. The reason for this is not apparent. Needless to say, some experimental data plotted in this way fall along straight lines which do not converge precisely on this focus, the divergence, however, is not large. In the figure, the courses of the curves beyond the ordinate for 3 cm depth are dotted, for actually at about this region the curves change their direction and incline toward the 100 per cent point. But practical use of this exponential relationship which obtains at depths greater than 3 cm can be made. For if the 10 cm percentage depth dose is known, either by direct measurement or by calculation with the aid of the nomograms, the doses at other depths, both greater and less than 10 cm, can be found. A line passing through the point indicating the known depth dose and the focus shown in the figure, intersects the ordinates for the various depths at abscissæ which indicate the approximate doses at those levels. The following example illustrates the method, and shows how far the results obtained by calculation agree with those obtained by physical measurement.

The data in Table VII are taken from Parker (6). The conditions of radiation

TABLE VII
(Data from Parker, 6)

1.5 HVL 150 sq cm Area, 60 cm Distance					
Depth in cm	10	8	6	4	2
Measured Values	40	50	62	77	91
Calculated Values	40	49	60	74	90

are given, and the percentage depth doses which were found by actual measurement. Below these appear the doses which have been obtained by calculation in the following way. First, from Figure 3 it is found

that with a beam having a half value in copper of 1.5 mm (the quality used by Parker), the percentage depth dose is 27.5 per cent, the area being 50 sq cm and the distance 40 cm. Next, with the use of the first nomogram it is found that under an area of 150 sq cm the depth dose is 36 per cent, when the distance is 40 cm. Using this value in the second nomogram, the depth dose, when the distance is 60 cm, is found to be 40 per cent. Finally, on Figure 4 a line is passed through the abscissa for 40 per cent on the ordinate for 10 cm depth and the focal spot. Along this line the depth doses for depths greater and less than 10 cm can be found. Some of these are shown in the table. The calculated values do not differ materially from the measured values. In this example, the correspondence is good even at 2 cm depth. But in general, at depths less than 3 cm the agreement is not very close. It has already been mentioned that in the region close to the surface, this method of calculating depth doses is not applicable.

REFERENCES

- (1) FAILLA G., QUIMBY E. H., MARINELLI, L. D., and ROSE J. E. *Am Jour Roentgenol and Rad Ther*, March, 1933, 29, 293-307
- (2) GREBE L., and NITZGB, K. *Sonderbände zur Strahlentherapie* 1930, 14
- (3) HOLTHUSEN, H., and BRAUN, R. *Grundlagen und Praxis der Röntgenstrahlendosierung*, Leipzig 1933
- (4) MAYNEORD W. V., and ROBERTS J. E. *British Jour Radiol*, June 1933, 6, 321-344
- (5) NASSELDORF D. N., and KATCHURA T. M. *Strahlentherapie* 1927, 27, 169-186
- (6) PARKER, H. M. *Acta Radiol* 1935, 16, 705-715
- (7) PARKER, H. M., and HONEYBURN J. *British Jour Radiol*, November 1935, 8, 684-696
- (8) QUIMBY E. H. *Am Jour Roentgenol and Rad Ther*, September 1936, 36, 343-349
- (9) QUIMBY, E. H. and MARINELLI L. D. *RADIOLOGY* July, 1933, 21, 21-29
- (10) QUIMBY E. H., COPELAND M. M., and WOODS, R. C. *Am Jour Roentgenol and Rad Ther*, October 1934, 32, 534-551
- (11) STONE R. S. and AEBERSOLD P. C. *RADIOLOGY* September 1937, 29, 296-304
- (12) TAYLOR L. S., and TUCKER K. L. *Am Jour Roentgenol and Rad Ther* June 1933, 29, 826-843
- (13) WEATHERWAX J. L. and ROBB, C. *Am Jour Roentgenol and Rad Ther*, May 1932, 27, 749-754

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

CALENDAR

Meetings Falling between the Dates of May 15 and June 30

May 20, 21 Pennsylvania Radiological Society at Traylor Hotel, Allentown

Editor's Note—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section.

CALIFORNIA

California Medical Association, Section on Radiology—Chairman, John D. Lawson, M.D., 1306 California State Bldg, Sacramento, Secretary, Karl M. Bonoff, M.D., 1930 Wilshire Blvd, Los Angeles. Meets annually with California Medical Association.

Los Angeles County Medical Association, Radiological Section—President, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena, Vice president, E. N. Liljedahl, M.D., 1241 Shatto St., Secretary, Merl L. Pindell, M.D., 678 South Ferris Ave. Treasurer, Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club—Chairman, Raymond G. Taylor, M.D., 1212 Shatto St., Los Angeles, Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco.

San Francisco Radiological Society—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club—President, John S. Bouslog, M.D., 246 Metropolitan Bldg., Vice-president, Sanford Withers, M.D., 304 Republic Bldg., Secretary, Ernst A. Schmidt, M.D., Colorado General Hospital, Treasurer, H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology—Chairman, Kenneth K. Kinney, M.D., 29 North Street, Willimantic, Vice-chairman, Francis M. Dunn, M.D., 100 State Street, New London, Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society

FLORIDA

Florida State Radiological Society—President, Gerald Raap, M.D., 168 S. E. First St., Miami, Vice president, H. O. Brown, M.D., 404 First Nat'l Bank Bldg., Tampa, Secretary-Treasurer, H. B. McEuen, M.D., 126 W. Adams St., Jacksonville.

GEORGIA

Georgia Radiological Society—President, James J. Clark, M.D., Doctors Bldg., Atlanta, Vice president, William F. Lake, M.D., Medical Arts Bldg., Atlanta, Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society—President, David S. Behn, M.D., 411 Garfield Ave., Vice president, Chester J. Challenger, M.D., 3117 Logan Blvd., Secretary-Treasurer, Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiological Society—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana, Vice president, Fred H. Decker, M.D., 802-Peoria Life Bldg., Peoria, Secretary-Treasurer, Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section of Radiology—President, Roswell T. Pettit, M.D., 728 Columbus St., Ottawa, Secretary, Ralph G. Willy, M.D., 1133 N. Leavitt St., Chicago.

INDIANA

Indiana Roentgen Society—President, J. N. Collins, M.D., 23 E. Ohio St., Indianapolis. President-elect, Stanley Clark, M.D., 108 N. Main St., South Bend, Vice-president, Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne, Secretary-Treasurer, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society

MARYLAND

Baltimore City Medical Society, Radiological Section—Chairman, Marcus Ostro, M.D., 1810 Eutaw Place, Secretary, H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society

MICHIGAN

Detroit X-ray and Radium Society—President, E. W. Hall, M.D., 10 Peterboro Street. Vice president

more successful by changes in technic. Fundamentally, the best technic he can employ is the one which does maximal permanent damage to the tumor while inflicting least harmful effect to the rest of the patient. A new idea which does not fulfill both these requirements is almost inevitably doomed to failure *ab initio*. Whether or not it is in fact a successful technic and an improvement on its predecessor, can ultimately be ascertained only by using it upon a large number of suitable cases, but it is highly improbable that a technic which, on paper, is a failure will prove a success in clinical use. Precalculation of tissue doses is, then, the first examination of the new idea. For this precalculation to give useful information, it is necessary to know what doses have been delivered to like tumors by the previous unsuccessful technics. This implies the availability of knowledge of tumor dosage throughout the routine work of the clinic.

The teaching of radiotherapy would be greatly simplified if the student were taught to think and work in quantitative terms of radiosensitivity and tumor dosage. At present, he is called upon to learn a large number of technics which, by usage, have been proved successful. These technics, however, are for the most part merely those in use in the clinic in which he works, and do not really give him a very wide view of radiotherapeutic knowledge. When he visits other clinics to broaden his knowledge, he sees methods being employed which are entirely new to him. Unfortunately, he is frequently confused, because not only the technic, but also the terminology used in describing it, is entirely unfamiliar. He is unable to correlate what he is seeing with what he learned in his training school. This fact not infrequently leads the visiting technician to leave a clinic with the erroneous impression that the work there "seems fairly good—but very haphazard," and thus he fails to appreciate the value to himself of what he has seen.

The usual site, to which

the standard technics are inapplicable always presents difficulties to the beginner. This is especially so if his approach to the case is, "I think my chief used to give somewhat similar sorts of things about a dozen applications through four or five fields at 200 kv and 20 ma, and a total skin dose of 3,000 or 4,000 r," and the lesion in question cannot be made to fit into this type of layout. If, on the other hand, he has learned to plan his treatments in terms of "I must deliver x roentgens in y days to that tumor with as little normal tissue damage as possible," his difficulties are greatly reduced. He has to aim at a definite goal defined in physical terms. He can precalculate the value of the various approaches which occur to him, and finally choose the one which fulfills the requirements of the case, or find that he is unable to deliver the requisite dose to this lesion and that, out of fairness to the patient, he must take some course less painful than an attempt at intensive therapy. From the teacher's point of view, it is very much simpler to be able to offer short simple facts about dosage than enter into long descriptions of technic each time he demonstrates a treated case.

In large clinics where several therapists are treating cases of similar type it is almost essential for the standardization of results that the tumor dose be known and recorded. In the Manchester Radium Institute (of whose staff I am a member) it is the custom to precalculate all doses, both radium and x-ray, in roentgens. Graphs show the milligram-hours needed to give 1,000 roentgens for different areas, and different distances, when radium is used, and depth dose phantom charts drawn up for the different tubes and applicators give the necessary information on the x-ray side. The output of the tubes is regularly checked by one of the physicists, but it is not customary to take physical measurements of treatments actually in progress. A complete record of all the factors employed in the treatment is filed with the patient's case notes for future reference. The dose actually given to each

heth's Hospital, Youngstown, *Secretary-Treasurer* Harry Hauser, M D, Cleveland City Hospital Cleveland Meetings at 6 30 P M at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists)—*President* George Benzing M D, St Elizabeth Hospital, Covington, Ky, *Secretary-Treasurer*, Justin E McCarthy, M D, 707 Race St., Cincinnati, Ohio Meetings held third Tuesday of each month

PENNSYLVANIA

Pennsylvania Radiological Society—*President*, Sydney J Hawley, M D, Geisinger Memorial Hospital Danville, *First Vice president*, William J McGregor M D, 744 Franklin Ave., Wilkeshurg, *Second Vice-president*, Oscar M Weaver, M D, 12 S Main St. Lewistown, *Secretary-Treasurer*, Lloyd E Wurster, M D, 416 Pine St., Williamsport *President-elect* Charles S Caldwell, M D, 520 S Aiken Ave Pittsburgh Annual meeting, May 1938 Exact date and place to be decided

Philadelphia Roentgen Ray Society—*President*, Thomas P Laughery M D, Germantown Hospital, *Vice president* Elwood E Downs, M D, Jeans Hospital, Fox Chase, *Secretary*, Barton H Young M D Temple University Hospital, *Treasurer*, R Manges Smith, M D, Jefferson Hospital Meetings first Thursday of each month from October to May, Thompson Hall College of Physicians 19 S 22nd St 8 15 P M

The Pittsburgh Roentgen Society—*President* F L Schumacher, M D, Jenkins Arcade *Secretary* H N Mawhunny, M D, Mercy Hospital Two Fall and two Spring meetings at time and place designated by president

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

South Carolina X-ray Society—*President*, Robert B Taft, M D, 105 Rutledge Ave Charleston, *Secretary-Treasurer* Hillyer Rudisill M D, Roper Hospital, Charleston Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society

TENNESSEE

Memphis Roentgen Club—Chairmanship rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

Tennessee State Radiological Society—*President*, H S Shoulders, M D 246 Doctors Bldg., Nashville, *Vice president*, S S Marchbanks, M D 508 Medical Arts Bldg Chattanooga, *Secretary-Treasurer*, Franklin B Bogart, M D, 311 Medical Arts Bldg, Chattanooga. Meeting annually with State Medical Society in April

TEXAS

Texas Radiological Society—*President* R. G. Giles, M D, Medical Arts Bldg San Antonio, *President elect*, Jerome H Smith, M D Shannon West Texas Memorial Hospital San Angelo, *First Vice president*, C F Cram M D 416 Chaparral St., Corpus Christi *Second Vice-president*, M H Glover, M D, 904 8th St, Wichita Falls, *Secretary-Treasurer*, G D Carlson M D, 3121 Bryan St., Dallas. Meets annually San Antonio is place of meeting, Oct. 22, 1938

VERMONT

See New England Roentgen Ray Society

VIRGINIA

Radiological Society of Virginia—*President*, Fred M Hodges, M D, 100 W Franklin St., Richmond, *Vice president* L F Magruder M D, Raleigh and College Aves, Norfolk *Secretary*, V W Archer, M D University of Virginia Hospital Charlottesville.

WASHINGTON

Washington State Radiological Society—*President*, H E Nichols, M D Stimson Bldg Seattle, *Secretary*, T T Dawson M D Fourth and Pike Bldg Seattle Meetings fourth Monday of each month at College Club

WISCONSIN

Milwaukee Roentgen Ray Society—*Secretary* S A Morton M D Columbia Hospital Milwaukee Meets monthly on first Friday

Radiological Section of the Wisconsin State Medical Society—*Secretary* Russel F Wilson M D, Beloit Municipal Hospital Beloit Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society in September

University of Wisconsin Radiological Conference—*Secretary* E A Pohle M D 1300 University Ave. Madison Wis. Meets every Thursday from 4 to 5 P M Room 301 Service Memorial Institute

THE FOCALOGRAPH

A NEW METHOD FOR EXAMINING THE TARGET OF A ROENTGEN-RAY TUBE^{1 2}

By CAPTAIN EDWARD K REID, A B, M D, Medical Corps Reserve, and STAFF SERGEANT LAWRENCE F BLACK, Medical Department, U S Army

From the Department of Roentgenology, Army Medical School, Lieut Colonel W W McCaw, Medical Corps, Director, Washington, D C

MANY methods have been proposed for the examination of the target of an x-ray tube. It must be conceded that any method which provides a permanent record for com-

(a) Providing a record of the appearance of the target of a roentgen tube (By enlargement obtained by increasing the grid-film distance it is possible to see minute defects plainly)

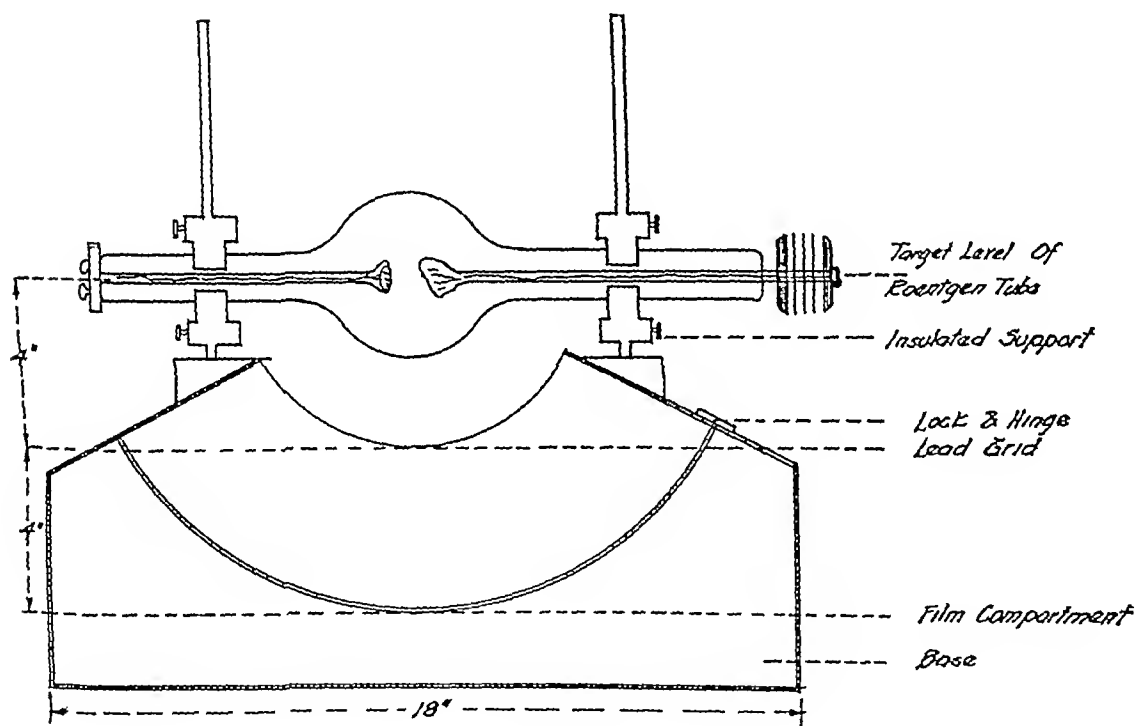


Fig 1 A

parison has advantages over methods which do not have this feature

The device described, the Focalograph, as proposed by Sergeant Black is a simple, economical, and efficient apparatus for

(b) Demonstrating the effect of angular position of the target of a roentgen tube upon the effective ray

(c) Checking the effective area, actual area and minimum projected area of the focal spot of a roentgen tube. This is especially valuable in checking performance of tubes against specification claims

(d) Determining the maximum ray divergence and minimum focal film dis-

¹ Approved by the office of the Surgeon General U S Army Washington D C

² This paper approved for publication purposes only. The authors' opinions are their own and for which the Surgeon General's Office accepts no responsibility

which in many respects was as far-reaching as the discovery of the circulation of the blood. By the aid of the microscope they were able to follow the course of injections of dyes into vascular and lymph channels, a method which was introduced by Belchier of Guy's Hospital in 1764, knowledge which has been astonishingly utilized by diagnostic radiology in the demonstration of the circulation in health and disease.

Contemporary with the Hunters was Edward Jenner (1749-1823) from whose work the whole fabric of preventive medicine and immunization was brought into existence. And here again radiology has carried the sense of sight to new heights of understanding of the fundamental conception of the etiology of disease and its prevention.

Early in the nineteenth century came evidence of growing interest in histology. Schneider and Schwann, in 1838, first described the cell, which Virchow said was the unit of life. And from Virchow and his school, through the cell theory, came a newer and better understanding of anatomy and physiology which he called "cellular pathology." The greater part of this new knowledge came from the study of material obtained at necropsy. However, while dead-house pathology gave an enormous amount of knowledge, it did not lead to rapid improvement in therapeutics. The physical changes resulting from terminal causes such as infections so often obscured the early disease manifestations that postmortem study gave too little understanding of the disease in its curable stages. Interpretation of the pathology of the living is the outstanding feature of modern medicine and in this field diagnostic radiology has been of incomparable service in carrying sight into the unseen spaces of the living body.

A hundred years after the Hunters, there were born two men, Pasteur (1822-1895), and Lister (1827-1912), through whom medicine was reborn. With improved microscopes and staining and cultural methods, Pasteur, of France, proved his theory of the origin of disease in micro-organisms, and changed the entire aspect of medicine. Lister, of England, related micro-organisms to infections and putrefactive processes, hospitals for the first time became safe, and modern surgery developed. Here again radiology has been the agent which has brought to the light the early manifestations of disease in concealed situations while in a curable stage.

In 1882, Koch, with cultural methods and the microscope, made his demonstration of the bacillus of tuberculosis. The disease tuberculosis had been one of the major causes of death of man, and it was learned from Koch's discovery, what had been suspected, that tuberculosis was not a hereditary disease, but that it was essentially contagious, that it was a disease of the lower animals as well as of man, although manifesting itself by attacking tissues not commonly involved in man.

Not until the twentieth century was the cause of syphilis determined, by Schaudinn, in 1905. Syphilis had existed from ancient times, and as the result of travel and admixture of peoples it spread over the world. With the scientific demonstration of the *Spirochaeta pallida*, medicine again advanced in its work of stamping out disease and prolonging the life of man. To-day, radiology, which demonstrates so readily the specific characteristics of these two great plagues, gives new knowledge of tuberculosis and syphilis.

But radiology has gone further: it has entered the field of physics and chemistry.

Radiology came from the development of the minute beyond the power of the microscope to reveal, and developed methods whereby not only the cell was broken up into atoms, but finally the atom itself was divided into its component parts. Information of enormous scientific importance had been developing since the work of John Mayow (1613-1679), of whom we have heard too little, one of the first of the physician-chemists. The observations and experiments of Mayow led later to the discovery of oxygen, and to-day, after nearly three hundred years, we are just beginning to understand those fundamental problems which connect physiochemistry with the medical sciences.

Brown, the English botanist, had long been making the observations in physics which culminated in his written communications of 1827. At about this period John Dalton was working on the atomic theory and the constitution of the molecule. Thomas Graham, Master of the Mint in London, in 1861 published his observations, which led to the first great description of colloid bodies. Tyndall called attention to the curious phenomenon occurring in the track of a luminous beam, the colorings of which are the effect of sunlight on colloids in the air, and investigated the transparency and opacity of gases and vapors under radiant heat.

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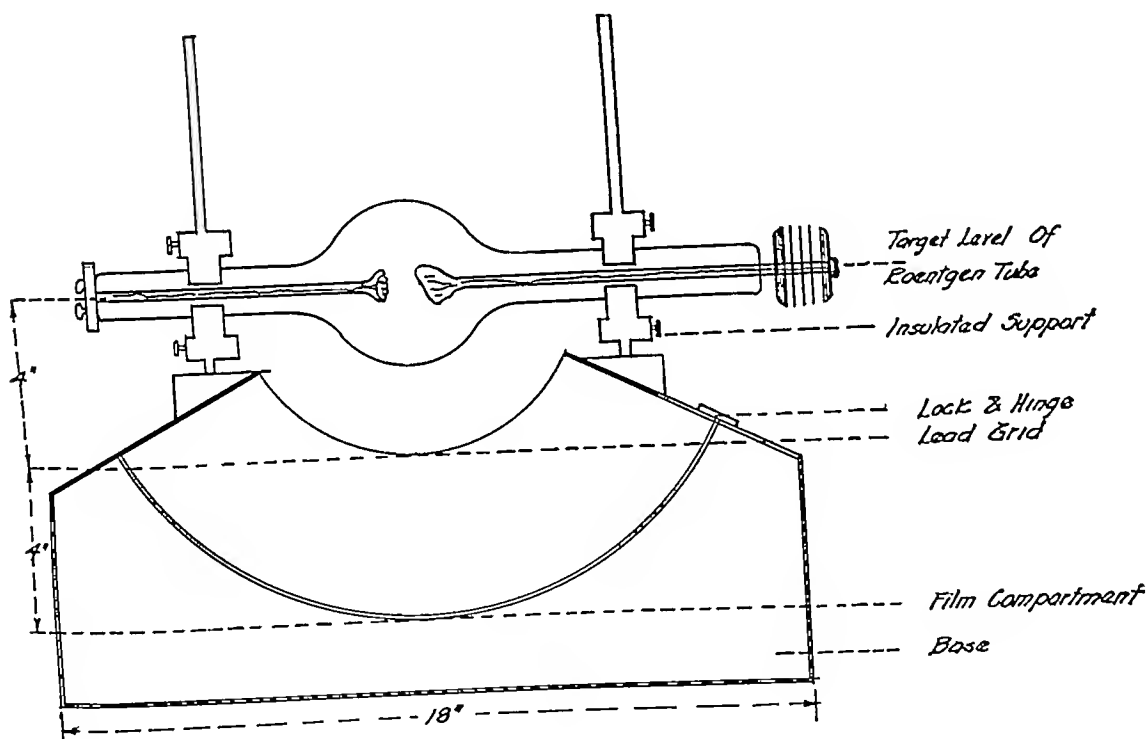


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bel Prize in Physics, and Ludvig Hektoen, M D, of the American Medical Association

The Institute is located at 21 West Elm Street, Chicago Mr Walter W Stevens is Administrative Officer

INDUSTRIAL RESEARCH LABORATORIES

Revision of Bulletin 91, National Research Council

The increase in the number of research laboratories maintained by industrial concerns in the United States during the last few years has made it seem desirable to issue a new edition of the National Research Council's Bulletin, "Industrial Research Laboratories of the United States," fifth edition

On March 25, questionnaires were mailed to the 1,562 concerns which were included in the last edition of 1933, and to a large number of new concerns which are thought to maintain laboratories

If the reader of this note is a member of a firm which maintains a laboratory where re-

search looking toward the development and improvement of products is carried on, it is hoped that he will ascertain whether a questionnaire has been received by his company, and if not, that he will request one from the Library, National Research Council, 2101 Constitution Avenue, Washington, D C

There is no charge for the entry in the bulletin, the only requirement being that the laboratory is undertaking research

It is desirable to have the information for the bulletin in hand as soon as possible so that the publication may appear within the current year

NOTE OF CORRECTION

The Editor wishes to call attention to an error in the caption of the cut on page 510 of the April issue of RADIOLOGY in which Dr W Edward Chamberlain is mistakenly named as Chairman of the American Board of Radiology He is, as is well known, Chairman of the Board of Chancellors of the American College of Radiology Dr B R Kirklin is Secretary of the American Board of Radiology

IN MEMORIAM

SANFORD WITHERS, M D

1891-1938

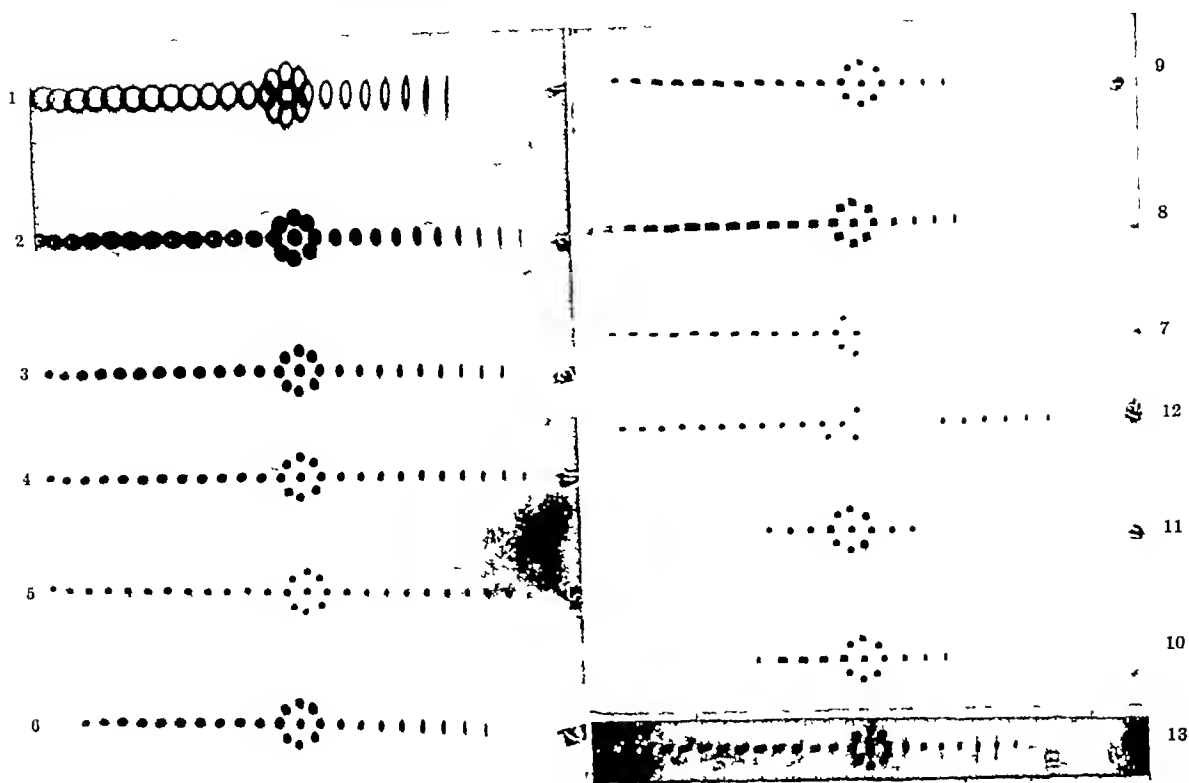
Sanford Withers, the son of George A and Avis Martin Withers, was born in Clearwater, Wayne County, Missouri, Nov 25, 1891 He received his primary school education in Piedmont, Missouri, and Lincoln, Nebraska, and his high school education at Manual Training High School in Kansas City, Missouri He graduated from there in 1910, one of the two boys to receive scholarships in engineering and architecture for Washington University, St Louis There may be some prophetic significance in the fact that he was one of the members of the senior class of Manual Training High School which, in 1910, helped build an x-ray machine

As the scholarship was not sufficient to cover his expenses at college, Sanford Withers delayed accepting it until 1912 In the meantime (1910-1911), to earn money enough to permit his attending college, he worked as assistant city chemist for Kansas City, Missouri He entered Washington University in 1912 and continued his studies there, with

chemical engineering as his goal, until some time during his third year, when he decided to go into medicine His medical course was interrupted in 1917 by his entrance into service for the World War He was a student with United States Base Hospital Unit No 21 from May 12, 1917, to March 19, 1919

After his discharge, he returned to Washington University and received his degree of Doctor of Medicine there in 1919 He was at the Barnard Free Skin and Cancer Hospital, St Louis, Missouri, from March, 1919, to July 1, 1920, as an interne, then as resident from July 1, 1919, to July 1, 1920, and as associate physician from July 1, 1920, to November, 1921 While in St Louis, Dr Withers was a member of Chi Zeta Chi medical fraternity (now Phi Rho Sigma) and the University Club From June, 1920, until November, 1921, he practised dermatology in St Louis

He moved to Denver in 1921 and that year was licensed to practise medicine there and was consultant for the Radium Company of Colo-



Figs 1-13

New Benson Focus Tubes, copper anode with tungsten button embedded

Dark spot— Actual focal spot
Medium halo—Outer ring of tungsten

Outer halo— Copper anode

8 Large side of Double Focus, X-P 1-4, General Electric

Also 20° anode (Fig 8)

Dark spot— Actual focal spot
Medium halo—Outer ring of tungsten

Outer halo— Copper anode

9 Westinghouse Line Focus Fluoroscopic Tube, copper anode with tungsten button (Fig 9)

Dark spot— Actual focal spot
Medium halo—Outer ring of tungsten

Outer halo— Copper anode

10 Philips Metalix 6 K W Tube, copper anode with tungsten button (Fig 10)

Dark spot— Actual focal spot
Medium halo—Outer ring of target
Outer halo— Copper anode

The small dark spots in the halo outside of focal spot are pins of tungsten holding the tungsten button in place

11 Westinghouse Right-angle Dental Tube, copper with tungsten button (Fig 11).

The filament is a tantalum ring through which both the cathode ray and x-ray pass in opposite directions. The effective size is the actual size. The halo is probably the filtration effect of the tantalum filament

Dark spot— Focal spot

12 Right-angle Dental General Electric, copper with tungsten button (Fig 12)

Note the very small amount of halo. This is old type tube and cathode, anode internal distance is very great

St Joseph's Hospital (Denver), of the American Medical Association, the Denver County and Colorado State Medical Societies, the Radiological Society of North America, the American Radium Society, the American Society for the Control of Cancer, the American Board of Radiology, the American College of Physicians, the American College of Radiology, the Denver Radiological Club, the Denver Public Health Council, the British Institute of Radiology, the Roentgen Society of London, Rouen Post of the American Legion (St Louis), and the Emulation Masonic Lodge (Denver). He was President of the American Radium Society, 1932-1933, and at the time of his death he was Chairman of the Colorado Committee for the American Society for the Control of Cancer, and Chairman of the Committee on Cancer Education of the Colorado State Medical Society. The bibliography of Dr Withers' publications reveals that they dealt almost entirely with the treatment of tumors and malignancies and were published in many journals.

These are the bare statements concerning Dr Withers' professional attainments. Nothing has been said about his love for his family and for the great outdoors. Only those who have been fortunate enough to have been with him on his various hunting and fishing trips could really know him as a companion and friend. For many years, he was afflicted with exophthalmic goiter, but in spite of poor health he carried on and was always interested in public health and the advancement of radiology.

W W WASSON, M D

BOOK RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgement of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

LE DIAGNOSTIC RADIOLOGIQUE DES TUMEURS MALIGNES DU PHARYNX ET DU LARYNX (*The Radiologic Diagnosis of Malignant Tumors of the Pharynx and Larynx*). An Anatomic-topographic and radiographic study. By DR F BACLESSÉ, Head of the Service at the Curie Foundation (Institute of Radium at the University of Paris). Preface by DR A HAUTANT. A volume of 270 pages, with 230 figures. Published by Masson et Cie, Paris, 1938. Price 100 fr.

BOOK REVIEW

EINFÜHRUNG IN DIE KURZWELLENTHERAPIE BEHANDLUNGSTECHNIK UND INDIKATIONEN (*Introduction to the Technique and Indications of Short Wave Therapy*). By DR ERNST FRITSCH and DR MARTIN SCHUBART, of Berlin, in collaboration with DR W GUTSCH, of Berlin, with an introduction by DR A ESAU. A volume of 200 pages, with 178 illustrations. Published by Urban & Schwarzenberg, Berlin, 1938. Price RM 5 50.

This introduction to short wave therapy is well prepared and illustrated. There are chapters on general considerations, physical principles, technique of short wave production and short wave apparatus, the physical differentiations between the tube apparatus and the spark gap apparatus, estimation of the performance of short wave apparatus, the electrodes, the foundations of treatment technique, biologic and therapeutic efficacy of short waves, treatment technique with short wave therapy in various diseases, short wave therapy in the treatment of eye diseases, the production of artificial fevers with short waves (electropylrexia, and short wave hyperthermia), and end-results. There is appended a good bibliography, particularly of the German and French literature on the subject. The authors recommend chiefly the use of the electrostatic field and, although they do discuss the use of the electromagnetic field, they give insufficient data on this phase of the subject. The book can be recommended to all physicians interested in short wave diathermy.

BACK-SCATTER AND ITS EFFECT ON DOSAGE MEASUREMENTS¹

By ROBERT S. LANDAUER, PH D, *Highland Park, Ill*

THE rationale for the use of voltages in excess of 200 kv p in x-ray therapy is, first, the greater depth dose obtainable, and second, a more favorable biologic reaction. The latter is problematical and is one which the clinical radiologist will have to prove or disprove as he gains more experience. The first is a perfectly definite physical problem, susceptible of relatively accurate physical measurement. It is the purpose of this paper to discuss one important aspect of this measurement, and thus enable the radiologist to avoid what might otherwise be a serious error in his concept of dosage.

Percentage depth dose is the ratio of the amount of radiation being absorbed at a given depth to the amount of radiation being absorbed by the skin. This percentage may be increased by increasing voltage to the x-ray tube, by increasing filter thickness, by increasing target-skin distance, and by increasing area or volume of tissue being radiated. As the area or volume of tissue increases the depth dose increases, due to an increase in scattered radiation. It is on this factor that we will concentrate our attention.

When an x-ray beam strikes a body such as human tissue several different things happen. Part of the radiation passes through the body unabsorbed and unchanged. Part of the radiation is absorbed. The energy of this absorbed radiation is used in ejecting an electron from the absorbing atom. It is the action of this secondary electron which is probably accountable for all the chemical, physical, and biologic effects of x-rays. Still another part of the primary radiation is scattered when it strikes the body. That is, it is bent out of the straight line which

it was traversing from the anode of the x-ray tube to the point of scattering. This scattering is analogous to the effect on a beam of visible light when a ground glass is interposed into its path. The light rays are bent from their original path, and the resultant image of the light source on the retina of the eye is blurred and hazy. There is no change in wave length of the visible light when it is scattered. Thus a red light, when viewed through a ground glass is still red. When x-rays are scattered, the result is different. There is a slight change in wave length, and most of the scattered rays are slightly longer than the primary unscattered rays. This change in wave length is so small that it was not until 1922 that its effect was noticed. Previous to that time it was thought that the scattered radiation had the same wave length as the original unscattered primary rays. Professor Compton, of the University of Chicago, made the experimental discovery of this change in wave length. The work was of such fundamental importance that he was awarded the Nobel Prize in Physics. For practical purposes, however, we can consider scattered radiation as having the same penetration as unscattered primary.

Scattering takes place in all directions in respect to the primary beam, with the greatest amount in the forward direction. However, some is scattered directly backward, and this portion of the scattered radiation is called back-scatter. Scattered radiation obviously plays an important rôle in dosage because it increases the amount of radiation being received by any given volume at any point in or on the radiated body. Obviously, the greater the volume being radiated, the greater the number of scattering sources, and hence the greater will be the radiation intensity at any given point within this volume.

¹ Presented before the 15th International Congress of Radiology at Chicago Sept 13-17 1937

- during the Healing Stage Following Roentgen Irradiation
- LAHEY, F H, and HOOVER, W B Pharyngo-esophageal Diverticulum Analysis of 53 Consecutive Operative Cases 655
- LAHM, W Roentgen Therapy of Benign Bone Disease 657
- LANGER, A, and SPRINDRICH J The Problem of Roentgen Dosage by Means of Photometry of Fluorescent Screens 655
- LAQUERRIÈRE, KUENTZ, and ROGET Radiotherapy in Diphtheria Carriers 661
- LEMOINE, J M, with RONNEAUX, G, jt auth 655
- LEUCUTIA, T and CORRIGAN, K E Coördination of Physical and Supervoltage Roentgen Therapy 662
- MARDERSTEIG, K The Value of Determining the Reticulocytes in Examining the Personnel of Roentgen Laboratories 656
- MARION G Gravel in the Kidney and Ureter 665
- MARTINET R, with OLTRAMARE, J H jt auth 664
- DU MESNIL DE ROCHEMONT, R Principles of Dosimetry in Radiation Therapy by the Rotation Method 662
- MILLER D K, and BARKER, W H Clinical Course and Treatment of Sprue 661
- MOEHLIG R C, and ADLER S Carbohydrate Metabolism Disturbance in Osteoporosis and Paget's Disease 657
- NOGIER TH Chronic Pararectal Fistula Treated with X ray Therapy Ten year Cure 664
- OLTRAMARE, J H and MARTINET R Urethrog-raphy 664
- OPPENHEIMER ALBERT Esophageal Varices 662
- OPPIKOFER E, JR Unusual Foreign Body in Esophagus and Stomach 664
- OSTERBERG, A E, with KEITH N M jt auth 660
- PATZÖLD J Measurements on Biological Phantoms with Very Short Waves and Great Energy 661
- POHLE, E A Radiation Therapy in Advanced Malignant Disease 659
- PONTHUS, P Radioscopy of a Plane of the Body Its Value and Practical Realization 655
- PORT, J with DECKER H jt auth 666
- PROUX CH with DELHERM jt auth 655
- ROGET with LAQUERRIÈRE, jt auth 661
- RONNEAUX, G, and LEMOINE, J M Stratigraphy of the Lung by the Method of Vallobona Presentation of an Apparatus for Stratigraphy the Oscillostrator 655
- ROOT, J C, with COLLINS E N, jt auth 664
- SCHINZ, H R Radiotherapeutic Five year Results in Carcinoma of the Cervix Treated during 1930 as Published in the Communication of the Section on Hygiene of the League of Nations 658
- v SCHUBERT E Six and One half Years' Experience in Cancer Therapy with Ultra hard Roentgen Rays 659
- SCHÜLLER, J So-called Arthritis Mutilans 655
- SCHUMACHER, A H, and STEEL DAVID Treatment of Carcinoma of the Bladder by 400 Kilovolts Roentgen Therapy 656
- SIMON STEFAN Anomalies of the Ribs in Childhood 655
- SMAGGHE H Bilateral Hydronephrosis 12 Cases 666
- SMYRNIOTIS, P C Calcification of a Bladder Infected with Bilharzia Dilatation of the Uterus and Implantation of Tumor 665
- SPRINDRICH J with LANGER A, jt auth 655
- STEEL, DAVID with SCHUMACHER A H, jt auth 656
- STREIL, W The Use of Roentgen Rays in Diphtheria Carriers 661
- THOYER ROZAT, P, and BERNARD JACQUES Roentgen Kymographie Study of the Phenomenon of Kienböck 660
- TRIMANI, A with COSSIO P jt auth 659
- VAN DER PLAATS G J Roentgen Caustic Its Principles and Application 662
- WALLACE, R P Traction Diverticulum of the Esophagus Roentgenographic Demonstration Symptoms Noted in Series of 26 Patients 663

radiologists think of dosage at the depth measured with scatter in terms of their ordinarily used air measurements. If the dose as measured in air is 200 r and the percentage depth dose is 40, the actual tissue dose to the depth is not 40 per cent of 200, as is so commonly assumed, but is 40 per cent of the skin dose, which would be 40 per cent of 200 plus the back-scatter. Assume that the back-scatter is 45 per cent, 45 per cent of 200 is 90, which makes the skin dose 290 r, 40 per cent of this skin dose would be 40 per cent of 290, or 116 r. If we had not included back-scatter, we would have calculated 40 per cent of 200, or 80, as the tissue dose. If we wish to think of percentage depth dose in terms of air measurements, which I think might be perfectly permissible, we must use as a percentage depth dose the ratio of 116 r to 200 r, or 58 per cent. If we consider the relation of skin dose to depth dose, the percentage is 40. If we consider air dose to depth dose, the percentage is 58.

This is of especial importance when considering depth doses at voltages higher than 200 kv p. With the more penetrating radiation delivered at these higher voltages, the percentage of back-scatter decreases. Table II shows this quantitatively.

TABLE II

KV P	Percentage Back-scatter
200	43
250	37
300	31
350	26
400	24

With 20 × 20 cm field and 3 mm copper filter

Table III shows the increase in percentage depth dose with increasing kilovoltage.

TABLE III

KV P	Percentage Depth Dose
200	42.5
250	45.0
300	45.5
350	45.8
400	46.0

With 20 × 20 cm field 3 mm copper filter 60 cm distance

Let us now compare depth doses at 200 and at 400 kv p, and see how extremely important it is to understand fully the implications of scattered and air measurements.

For every 200 r measured in air at 200 kv p, there would be 42.5 per cent of (200 plus 43 per cent back-scatter), 43 per cent of 200 is 86, giving a skin dose of 286 r. Taking 42.5 per cent of 286 gives us 123 "tissue roentgens".

For every 200 r measured in air at 400 kv p, there would be 46 per cent of (200 plus 24 per cent back-scatter), 24 per cent of 200 is 48, giving a skin dose of 248. Taking 46 per cent of 248 gives us 114 "tissue roentgens".

This is rather startling, for it tells us that if we make our measurements in air, the same dose will give less tissue dose at 400 kv p than it will at 200 kv p.

If, however, we measure with back-scatter, the effect will be the expected one. In order to get a true picture, we must compare depth doses with equal skin doses—not with equal air doses. With equal air doses, the skin dose is less with 400 kv p than it is with 200 kv p and the depth dose is also less. To get comparable depth doses, we must administer 287 r at the skin with 400 kv p, which will give us a proper equal basis for comparison. The tissue dose with 400 kv p then becomes 45 per cent of 286, or 132 r, as compared with 123 r at 200 kv p.

The skin dose with 200 kv p is 286, while the skin dose with 400 kv p is 248, the former being 15 per cent more than 248, it therefore takes 15 per cent more r as measured in air to give the same tissue depth dose with 400 kv p as with 200. The practical result of this is that the radiologist who has been accustomed to administering 200 r in air at 200 kv p, and who then changes to 200 r in air at 400 kv p, is actually giving less radiation to the depth at 400 kv p than he was at 200. Hence, in order that proper advantage may be taken of the slight increase in depth dose of 400 kv p over

lated tabes dorsalis. It is difficult to distinguish between them and indeed it is very likely that the arthropathy resulting from tabes dorsalis, syringomyelia, and spina bifida are similar entities. In the series, two cases were spina bifida, two myelodysplasia, and the remaining two presented vague but not definitely diagnosable neurologic symptoms. Numerous terms have been applied by other authors to lesions presenting very similar signs and symptoms, and probably all these should be included under one terminology, viz., Kienböck called the foot lesions "trochopathia myelodysplastica," Blum considered these lesions as "osteoarthropathia micro-atrophicans," and more recently they have been called Stursberg's polyarthritis mutilans."

WILLIAM R. STECHER, M.D.

Roentgen Therapy in Acute Para arthritis. Alfred A. de Lorimier. *Am Jour Roentgenol and Rad Ther*, July, 1937, 38, 178-195.

In cases manifesting aches or neuralgic pain which are concerned with the motion of a joint in the extremities, a localized inflammation of the tendons of one or more muscles within a sector of the joint periphery must be considered. This the author calls "para arthritis" and includes involvements of the bursa. The shoulder, elbow, hand, hip, knee, foot, or any joint may be involved. Under this heading fall the so-called bursitis, tendonitis, Pellegrini-Stieda's disease, etc.

Most of these cases present symptoms out of proportion to the findings, especially pain, point tenderness, and impaired motion, and roentgenologically, a calcareous deposit. Although trauma is a factor, a large percentage gave no history of it and, therefore, a toxic condition must be considered.

In the acute cases roentgen therapy produces a prompt cure in a few days, some even after only one treatment, though the most effective was application through very small cross-firing fields of 400 r daily to a total of 2,400 r with from 140 to 200 kv. The calcareous deposits disappeared in the acute, were not affected in the symptomless, and varied in those with mild or moderate symptoms, though the symptoms improved.

S. M. ATKINS, M.D.

Several Cases of Gonococcal Arthritis Treated by X-ray. M. L. Guillaumet. *Bull et mém Soc de Radiol méd de France*, October, 1937, 25, 652-656.

Although x-rays have been successfully used in the treatment of gonococcal arthritis ever since 1904, they are not generally enough employed at the present day. The author presents a series of 21 cases treated with roentgen rays. He finds that in the majority there is an almost immediate amelioration of pain and swelling and that hospitalization is considerably shortened and the arthritic sequelae are markedly reduced. He advises a dosage of 200 r, given every few days as required.

by the duration of the disease. Certainly this method of treatment should be used more often as there is no doubt of the beneficial results.

S. R. BEATTY, M.D.

THE BLADDER

Treatment of Carcinoma of the Bladder by 400 Kilovolts Roentgen Therapy. A. H. Schumacher and David Steel. *Ohio St Med Jour*, October, 1937, 33, 1116-1118.

In spite of the pessimistic attitude generally taken in regard to the treatment of carcinoma of the bladder by external irradiation, the authors feel encouraged by the survival of nine cases out of fifteen treated and quote favorable results from other clinics. The far advanced cases received only palliative treatment but those in better condition were given full doses ranging up to 14,000 r, equally divided over two anterior and two posterior ports. The factors used were 400 kv constant potential, 5 ma, 80 cm distance, filter 0.93 mm tin plus 0.27 mm Cu plus an ionometer chamber plus bakelite plus 2 mm Cu built into the tube, giving a filter having the equivalent of 6.5 mm Cu.

J. C. ROBINCK, M.D.

THE BLOOD

The Value of Determining the Reticulocytes in Examining the Personnel of Roentgen Laboratories. K. Mardersteig. *Strahlentherapie*, 1938, 61, 379.

The author had an opportunity to examine the blood of employees of a roentgen tube factory. There were changes in the white blood picture and occasionally an increase in the erythropoietic function which expressed itself in an increase of the reticulocytes or the hemoglobin and the erythrocytes. Chronic tonsillitis very often accompanied by pharyngitis and laryngitis was also found. This is chiefly due to the influence of ozone and nitrous gases; the described changes disappeared after the causative agents were removed. The author concludes that the determination of the reticulocytes is a reliable method for the recognition of bone marrow stimulation in persons working in x-ray laboratories.

ERNST A. POHLE, M.D., Ph.D.

BONE DISEASES (DIAGNOSIS)

Fibrocystic Disease and Hyperparathyroidism. J. Bauer and A. Jung. *Rev Chir*, April 1937, 75, 284-295. (Reprinted by permission from *British Med Jour*, July 31, 1937, p. 17 of *Epitome of Current Medical Literature*.)

The authors report an interesting case of a woman 34 years of age who complained of a violent pain in the right thigh and hip after a fall. A diagnosis of a neoplastic metastasis in the right femur was made roentgenographically and roentgen therapy was given with some success. Two years later there were similar

SOME FACTORS INFLUENCING THE DISTRIBUTION OF RADIATION USING A TWO-OBLIQUE-FIELD TECHNIC

By M C REINHARD and F MIERS, *Buffalo, N Y*

From the State Institute for the Study of Malignant Diseases
Burton T Simpson, M D , Director

IN the treatment of pelvic malignancies by means of x-radiation, there has been during the past decade a progressive increase in the target-skin distance, resulting in an increased intensity at depth. To-day 200 kv x-ray treatments are given at target-skin distances of 80 centimeters or higher. Obviously the simplest technic is to use one large 20×20 cm field anteriorly and posteriorly. The large field radiates the entire pelvis and due to the scattering from such a large volume of irradiated tissue, the depth intensity at a point 10 cm below the skin may be as high as 50 per cent of the skin dose. Mattick (1) has published tables simplifying the procedures in calculating the dose by this technic.

In cases in which still greater intensities at depth are desired four or even six fields may be applied. Following the suggestion of Weatherwax (2) long narrow rectangular fields should be used, two anteriorly and two posteriorly (and two lateral) and the radiation directed so as to overlap in the midpelvic region. This latter method was adopted at the State Institute several years ago with the angulation of the beams and the separation between the two anterior and two posterior ports predetermined. In view of the fact that the patient was treated at one sitting with only one, or at most two, ports per day over a period of from 40 to 50 days, a variation from day to day in the angulation or spacing of the ports could be very easily introduced. The question arose, therefore, as to how significant such slight daily variations might be in routine treatments.

The present paper deals with ionization measurements made in a water phantom which was radiated by two simultaneous beams of radiation in order to arrive at

some conclusions regarding variations in the set-up and the resulting errors.

The physical set-up for these measurements was as follows:

Two XPT type tubes excited simultaneously by one generator, were operated at 200 kv p and 10 ma. The intensity in air and the half-value layer of copper were determined for each tube separately with the radiation from one of the tubes cut off by means of a lead shutter. The output from each agreed with that of the other and, in addition, the quality of the beam was the same as with a single tube operated at the same voltage and 25 ma, namely, 1.0 mm copper half value layer.

Each tube could be rotated on its long axis so as to permit the adjustment of the angulation of the two beams. The radiation from both tubes was confined and directed by means of wood treatment cones lined with lead rubber for the entire treatment distance of 80 centimeters. The fields were 10×15 centimeters. With the long axes of the fields parallel the radiation was directed into the water phantom with the following angulation and spacing:

1 Each beam inclined 6° away from the perpendicular

2 Each beam inclined 11° away from the perpendicular

3 Each beam inclined 16° away from the perpendicular

A second adjustment was provided so that the phantom end of the treatment cones in each of the three angulations could be touching, separated 2 centimeters or 4 centimeters, giving, in all, nine combinations.

The water phantom was $32 \times 50 \times 26$ cm high, with provision made to insert a thimble ionization chamber at various

treatment of benign disease by roentgen rays Osteomyelitis, localized osteitis fibrosa cystica giant cell tumor, and osteitis deformans are included Illustrative cases with roentgenograms are appended One case of osteitis deformans of the pelvis and femur is interesting because the patient was unable to walk at the time of admission He responded so well to roentgen therapy that he is now able to work from 10 to 12 hours and to walk without difficulty In spite of this clinical improvement the roentgenogram shows no changes as compared with the findings before the treatment

ERNST A POHLE M D Ph D

BREAST CANCER

Carcinoma of the Male Breast Carl A Kunath Jour Iowa St Med Soc January 1938, 28, 10-13

Six cases of carcinoma of the male breast have been diagnosed at the University of Iowa Hospitals in the last ten years This is approximately 1.27 per cent of all breast cancers admitted during this period and corresponds closely to the incidence given by other authors There is general agreement that breast cancer in the male has a much gloomier prognosis than in the female The reasons for this are not clear but the author believes that the factor of late diagnosis due to failure of the medical profession to recognize that the disease exists in the male may play a large part Pain has been reported to be the most common symptom in males and to occur earlier Ulceration of the skin is more frequent even in the earlier stages The same is true of muscle involvement and fixation of the chest wall In the author's six cases the first symptom noted was a mass Pain was prominent in two cases but none had a discharge from the nipple or fixation to the chest wall axillary node involvement was present in four cases one gave a history of trauma preceding the development of a mass, microscopically all were adenocarcinomas It is generally agreed that the treatment should be the same as for the female i.e. radical amputation and irradiation Of the six cases reported only four survived the operation Of these four one is living and has a local recurrence two died 14 and 17 months after operation respectively and one died two and one-fourth years later probably from other causes

L W PAUL M D

CANCER (DIAGNOSIS)

Extensive Radiologic Defects Corresponding to Cancers Not Found by the Surgeon M R A Gutmann Bull et mém Soc de Radiol méd de France October 1937 25, 599-603

The author describes several cases with large radiologic defects which were not demonstrable at operation. Such a defect may be a pseudo-tumor due to functional causes or a tumor such as a lymphoblastoma which is of very soft consistency and not therefore palpable at operation Sometimes edema from gastritis or gastric

ulcer will produce large masses which cannot be found at operation but which disappear under proper treatment

S R BEATTY, M D

CANCER (THERAPY)

The Biological Principles of Radiation Therapy of Malignant Tumors with Fractional Doses J Borak Strahlentherapie, 1938 61, 63

The author reviews the history of the development of the fractional dose method in roentgen therapy and points out that Freund of Vienna created the method that Schwarz furnished the theoretical background Regaud the experimental foundation while Coutard used it in clinical practice

ERNST A POHLE, M D Ph D

Radiotherapeutic Five-year Results in Carcinoma of the Cervix Treated during 1930 as Published in the Communication of the Section on Hygiene of the League of Nations H R Schinz Strahlentherapie 1938, 61, 38

In March 1937, Heyman published on request of the radiological subcommittee of the League of Nations a statistical report giving the five-year end results obtained in the treatment of carcinoma of the cervix during 1930 in six clinics One was located in Brussels one in Liverpool two in London one in Paris and one in Stockholm A total of 757 patients were observed 80 per cent of these were treated An average of 31 per cent were free from symptoms at the end of five years although the individual results of the six clinics varied from 17 (47 per cent) Schinz presents a critical analysis of these figures and attempts to explain the discrepancies in the end results He comes to the conclusion that neither the selection of the cases nor the error due to small numbers explains it One might consider the influence of race and age Furthermore the differences in the methods of radiation therapy should be studied no data on these are given in Heyman's publication He suggests therefore a comparison of the treatment methods used in the six clinics on whose records Heyman's report is based

ERNST A POHLE M D Ph D

Indications for X-ray Therapy H Holfelder Wien Klin Wchnschr July 16 1937 50, 1051-1054 (Reprinted by permission from British Med Jour Sept 18 1937 page 41 of Epitome of Current Medical Literature)

Holfelder gives the results of his extensive experience in the treatment of malignant growths with x-rays and compares them with those obtained by operation In small carcinomas of the skin surgery and irradiation give equally good results whereas extensive inoperable skin carcinomas can be treated only by irradiation

surface immediately below the center of either treatment cone, and curves were constructed for the depth intensities at the

angles, 6° , 11° , and 16° , and the three separations, namely, touching, 2 centimeters and 4 centimeters between the two cones

OBSERVATIONS

First—The distribution of the radiation and the relative intensities at the different depths are somewhat different than that which would be obtained by superimposing two separate isodose curves. The difference may be due to the fact that the ionization chamber measures the average intensity for a definite volume, whereas in the latter condition the intensity is obtained by a summation of the intensities from the two separate curves at a point below the skin

Second—These curves indicate the angulation and spacing necessary to avoid or to produce so-called "hot spots" where desired, as the particular case to be treated may require.

Third—A daily variation in the setting up of a patient on whom only one area is treated at a time, could very easily result in a marked difference in the amount and distribution of the radiation in the region in question

Fourth—Isodose curves obtained from measurements made when only one beam of radiation was used, agree with those published by May (3) for the same angulation

BIBLIOGRAPHY

- (1) MATTICK, WALTER L. Some Practical Considerations in the Application of Deep Roentgen Therapy to the Treatment of Malignant Disease. *RADIOLOGY*, July 1926, 7, 3
- (2) WEATHERWAX, J. L., and ROBB, CHARLES. Water Phantom Intensity Measurements of High Voltage Roentgen Rays (200 kv peak) at 70 and 80 Centimeter Skin target Distances. *RADIOLOGY*, April, 1934 22, 426-431
- (3) MAY, ERNEST A. Depth Doses of Roentgen Radiation, Striking at Angles Other than 90° , Measured in a Water Phantom. *RADIOLOGY*, May, 1934, 22, 559-568

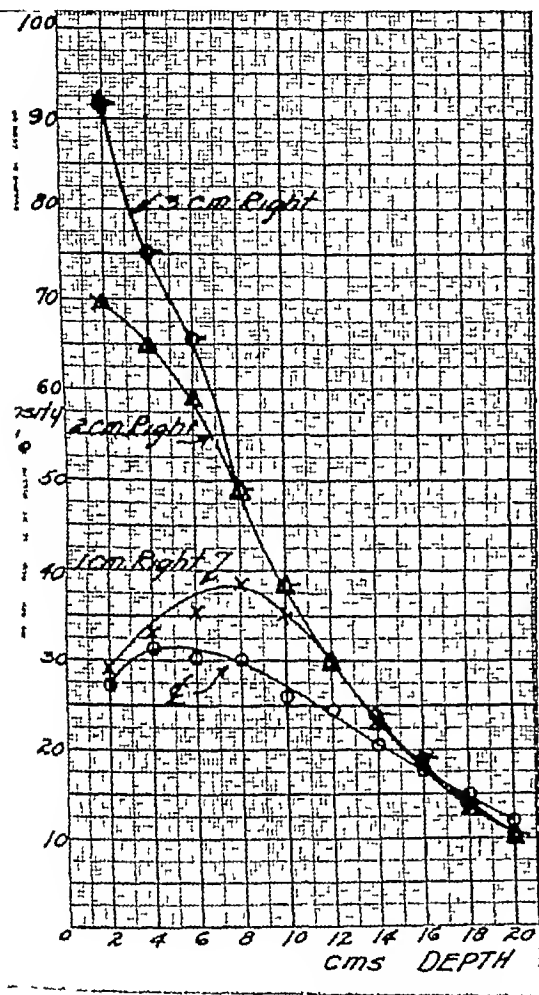


Fig 10 Two 80 cm 10×15 boxes separated 4 centimeters

various positions. Figure 10 shows part of a family of such curves

From such families of curves, one lateral half of the final isodose curve was constructed, the other half being, of course, merely a mirror image of the first half. The nine complete isodose curves are shown in Figures 1 to 9, representing the three

diac lesion was found, while in 22 per cent there were no lesions. In no case showing cardiac lesions with marked enlargement was the sign found.

Based on autopsy findings the authors believe that the triangular para-apexian shadow is due to a ligament extending from the dome of the left leaf of the diaphragm to the lower part of the parietal pericardium, the presence of fat being only contributory.

A MAJORAL M D

Roentgen Kymographic Study of the Phenomenon of Kienböck. P Thoyer-Rozat and Jacques Bernard. *Jour de radiol et d'électrol* November 1937, 21, 499-502.

The authors have studied the phenomenon of Kienböck with the kymograph and have demonstrated that the paradoxical movement of the fluid level of hydro-pneumothorax is due to shift of the mediastinum rather than to paralysis of the diaphragm.

S R BEATTY, M D

COLITIS

A Review of Idiopathic Ulcerative Colitis with Report of Five Cases. Jonas C Kopelowitz. *Jour Missouri St Med Assn*, February 1938, 35, 41-48.

The recent literature on ulcerative colitis is reviewed with special reference to etiology, symptomatology and treatment. Many organisms have been incriminated but especially the *B dysenteriae* Bagen diplostreptococcus and the *B coli*. Many workers—and there is a definite trend toward this view—feel that ulcerative colitis belongs to the dysentery group. Bagen has been the chief exponent of the diplostreptococcus but his views have not found universal acceptance. The theory of an avitaminosis has some supporters since ulcerative colitis has a close resemblance to sprue and pellagra.

Concerning incidence, ulcerative colitis shows no seasonal variations and affects both sexes equally. The disease is most common between the second and fourth decades, with the average age about thirty. The duration varies from a week to twenty years or longer.

Symptomatically cases may be divided into three groups: (1) The non-toxic non-sclerotic with no evidence of toxemia or systemic manifestations; (2) the non-toxic, sclerotic with marked permanent changes to colon and rectum with rigid contracted and stenosed bowel from long standing colitis; (3) the toxic with septic fever, leukocytosis, anorexia, nausea, vomiting, rapid pulse, and prostration. This group includes those cases with rapid onset in which no treatment seems to be of avail (about 5 per cent of all cases).

Many forms of treatment have been advocated. This should include rest in bed during the acute stage, outdoor régime when improved, sunlight and ultra-violet light to the abdomen. The diet should be one with a low residue and with a caloric value of about 3 000 per day. Vitamins should be given either as a concentrated preparation or in the form of orange

juice, tomato juice, butter, and yeast. A wide variety of oral, rectal and intravenous medicaments have been advocated.

The results of surgical treatment are not encouraging. Conservative surgery, preferably ileostomy, is indicated if medical management fails to control the symptoms. It is recommended, also, in the presence of massive hemorrhage, persistent fever and rapid pulse, persistent nausea and vomiting, or continued bloody diarrhea not improved by repeated blood transfusions. In the author's series of 34 cases, operation was done in six with three deaths. There were four other deaths without surgery, a total mortality of 20 per cent.

Five typical cases are summarized and illustrative roentgenograms are included. A bibliography of 50 articles, mostly of the more recent literature, is appended.

L W PAUL, M D

CONTRAST MEDIA

Acute Bismuth Poisoning with Recovery. N M Keith and A E Osterberg. *Arch Int Med* September 1937, 60, 415-423.

Two cases of acute bismuth poisoning are presented resulting from cystographic injection of an alkaline solution of bismuth and potassium tartrate. Onset symptoms were characterized by rapid development of oliguria or anuria within from 24 to 48 hours, accompanied by nausea and vomiting. Stomatitis and bleeding from the gums developed three or four days after the onset. Characteristic blue-black discoloration of gums and mucous membranes did not appear until several days later. There was a marked rise in concentration of blood urea and creatinine, and a decrease in the bicarbonate reserve and chloride concentration of the plasma.

Treatment consisted of intravenous injection of 1 per cent sodium chloride from 5 to 10 per cent dextrose, and 5 per cent sodium bicarbonate daily injections totalling from 1 000 to 3 000 c c. In one of the cases sodium thiosulphate did not appear to affect the toxemia.

The authors point out the similarity between bismuth toxemia and that produced by other heavy metals especially mercury bichloride. In lead poisoning renal insufficiency does not occur.

H A JARRE, M D

THE CRANIUM

Intracranial Projectiles. M Alfred Lévy. *Bull et mem Soc de Radiol méd de France* October 1937, 25, 630-635.

The author presents two cases in which bullets inside the cranium migrated downward and backward toward the base. He believes that the weight of the lead bullets is the determining factor in this migration.

S R BEATTY, M D

ROENTGEN DIAGNOSIS

The application of the roentgen ray may be of diagnostic aid in these conditions in the following ways (1) in showing enlargement of the gland, in detecting pressure phenom-

angular shadow which narrows as it passes upward toward the first rib. At its narrowest point it is less than the diameter of the spinal column. The trachea is in the midline behind the aorta, bifurcating at

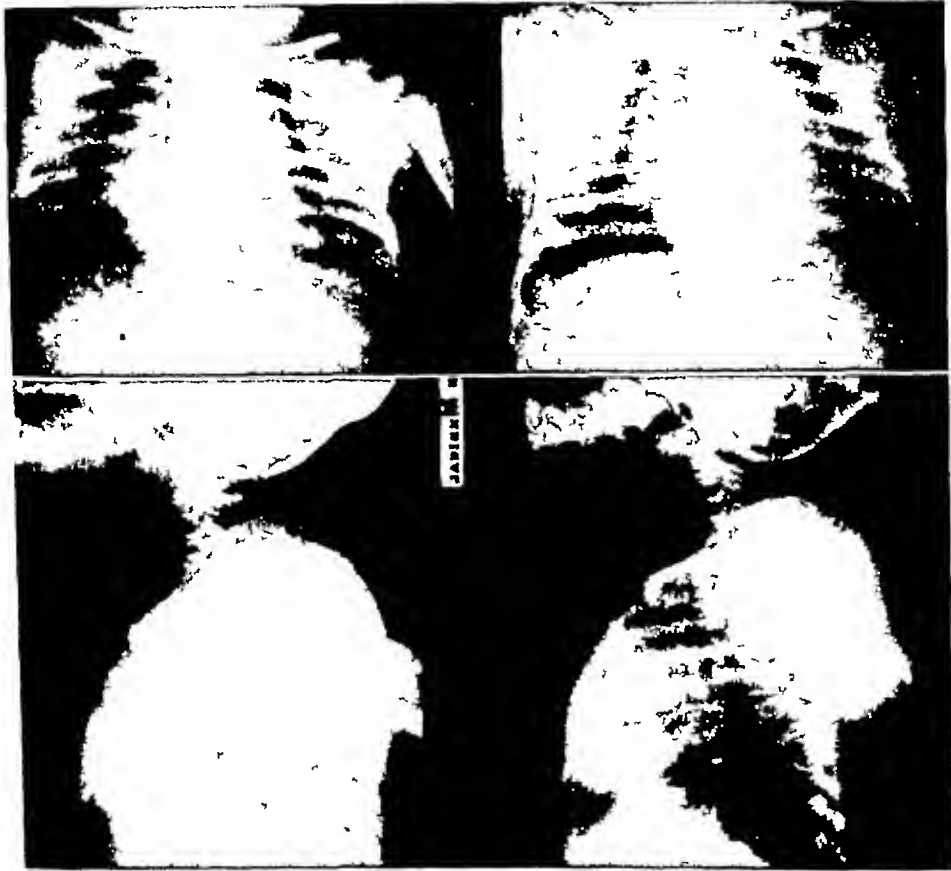


Fig 2. Definitely enlarged thymus. Thymic shadow nearly 8 cm wide and over four times the width of the thoracic vertebra. Narrowing of the trachea in the lateral view.

ena, particularly of the trachea, the possible diagnostic value of a therapeutic test with roentgen rays.

Normal Roentgen Appearance—The normal infant's chest, so well described by Wasson (1) in his observations on the anatomy of the thymus gland, shows in the anteroposterior views (Fig 1) two auricles and the great vessels forming the base of the heart shadow, the superior vena cava at the right and the pulmonary artery on the left. The aorta lies in the midline, only in later life does it project to form the aortic arch. These structures form a tri-

angle about the third thoracic vertebra, the esophagus lies behind the trachea and is not seen. The thymus is included in the superior mediastinal shadow, its base overlapping the base of the heart. It is usually widest at the third interspace. In the recumbent postero-anterior position at full inspiration, the normal mediastinal shadow at the second interspace is about one and one-half times the width of the body of a dorsal vertebra. The lateral view should show the pharynx, posterior border of the tongue, epiglottis, vestibule of the larynx, retropharyngeal space, and

The half value layers in copper for the 400 kv ranged from 3.6 mm to 5.2 mm, compared with 1.1 mm for 200 kv. Depth doses for 400 kv with different field sizes at 50 cm focal distance showed a considerable difference, but at 80 cm somewhat less. Back scattering at 400 kv, even for large areas, was slightly more than 20 per cent as compared to over 40 per cent for 200 kv.

S M ATKINS, M D

Certain Conclusions from Study of Radiation of 200-400 Kilovolts with the Photoelectric Cell. Andre Demer. Bull et mém Soc de Radiol méd de France, October 1937, 25, 651-652.

The author has made a study of the effects of x rays on the reading of the photoelectric cell in the region from 200 to 400 kv. He finds that below 0.15 Å the sensibility falls rapidly toward the region 0.083 Å. There is a sharp drop between 0.10 and 0.150 Å which is of interest in that it may allow a means of measuring quality of a given radiation in this range but makes the instrument unsatisfactory as a measure of quantity. With a given quality of ray a remarkable proportionality of the current with the intensity of irradiation exists which can be verified by changing the distance only and applying the law of the square root.

S R BEATTY, M D

Roentgen Caustic: Its Principles and Application. G J van der Plaats. Strahlentherapie, 1938, 61, 84.

The author suggests the term "roentgen caustic" for the method of applying roentgen rays at relatively low potentials, short focal skin distance with high intensities and large doses. This method has been developed during the last few years by Chaoul and his co-workers. The principles of the method are discussed at length. Its great advantage is the rapid drop of the dose from the surface toward the depth. If it is not desirable to preserve the integrity of the skin, unfiltered radiation at the shortest possible distance is the method of choice. A special apparatus which permits irradiation at 50 kv, no filter, 2 cm FSD is described and its advantages in focusing the beam on the lesion demonstrated.

ERNST A POHLE, M D, Ph D

Coordination of Physical and Biological Dosage in High Voltage and Supervoltage Roentgen Therapy. T Leucutia and K E Corrigan. Am Jour Roentgenol and Rad Ther, November, 1937, 38, 762-768.

It is recommended that the physical dose be always coordinated with the biological dose when prescribing a certain radiation treatment.

For the present the skin erythema still appears as the most suitable biological indicator and therefore it is recommended that it be used routinely as a biological dose unit. Since with increasing voltages an increasingly larger physical dose can be administered to produce a similar erythema, a curve expressing this rela-

tion will be of great clinical aid. This type of curve may serve as a basis for the derivation of other curves, such as, for example, the curve expressing the measurement of roentgens in free air, equivalent curves for various size fields by taking into consideration the surface scattering, curves expressing the time factor when treatment is fractionated and protracted, etc.

The physical dose should always include a statement of (a) the quality of the radiation, expressed in the form of a complete absorption curve describing the equivalent voltage or half value layer, (b) the quantity of the radiation expressed in roentgens, measured in free air with a thimble chamber, (c) the intensity factor (r/min) and (d) the time factor or daily loss of radiation effect, if treatment is extended over a certain length of time. Finally, it should include a detailed description of all factors pertaining to technique, such as radiation source calibration and clinical procedure.

S M ATKINS, M D

Roentgen Therapy with Supervoltage in North America. O Glasser. Strahlentherapie, 1937, 60, 557.

The author describes several of the supervoltage installations in this country and briefly discusses some of the problems in dosimetry.

ERNST A POHLE, M D, Ph D

Principles of Dosimetry in Radiation Therapy by the Rotation Method. R du Mesnil de Rochemont. Strahlentherapie, 1937, 60, 648.

The author investigated the various factors affecting dosage in irradiation with the rotation method (see also paper by Dessauer same journal, 1937, 60, 546). Numerous mathematical deductions are given showing the relation between focal skin distance, field size, and surface and depth doses. The differences in the isodose curves as compared with those obtained when patient and tube arc immobilized are also shown. Blanks are reprinted which permit the recording of the doses in practice.

ERNST A POHLE, M D, Ph D

THE ESOPHAGUS

Esophageal Varices. Albert Oppenheimer. Am Jour Roentgenol and Rad Ther, September 1937, 38, 403-414.

The roentgenologic appearance of esophageal varices is the product of two variable factors, namely anatomical formation and actual physiological condition during exposure.

Anatomically the roentgen findings vary with the stage of the disease. The early stage, marked by a slight and diffuse congestion, results in moderate broadening of the rugæ of the lower esophagus. The beginning of the dilatation of the large veins results in small rounded defects of the lower fifth of the esophagus. The generalized enlargement of numerous veins

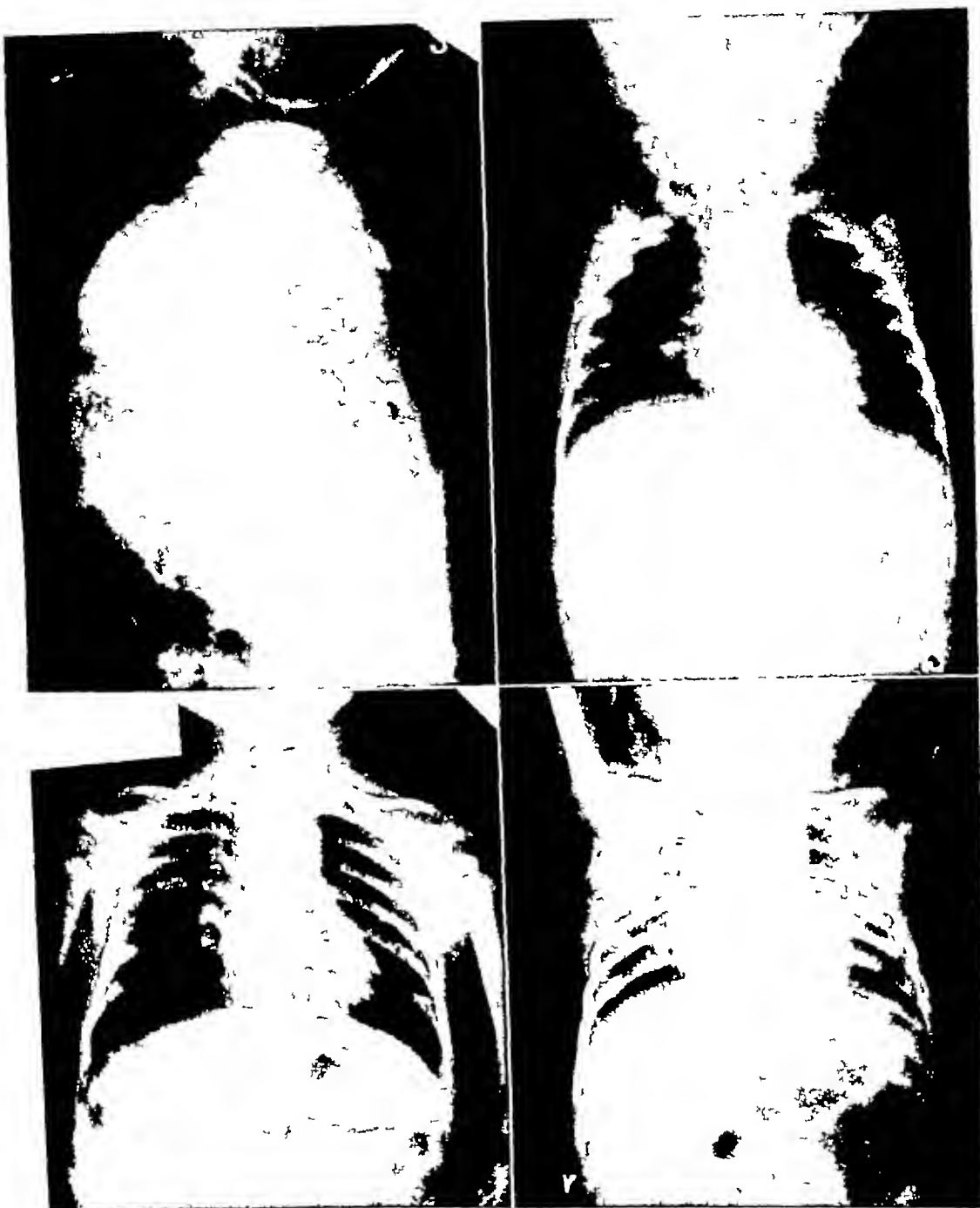


Fig 4 (above) 1 also impression of buckling and compression of the trachea in the lateral view. This is due chiefly to distortion from rotation of the patient and also to the fact that the film was taken during expiration.

Fig 5 (below) Normal thymus with change in width due to respiration. The film on the left was taken at full inspiration and is essentially negative. The film of the same patient on the right was taken at expiration and shows an apparently enlarged thymus. This is entirely a physiological effect, but often leads to a mistaken diagnosis of enlarged thymus.

in a child without definite symptoms, is that a warning signal of possible danger?

REVIEW OF LITERATURE
There is a definite trend, particularly in

to occur without symptoms the author presents an analysis of 26 cases discovered roentgenographically, ten of which had symptoms directly traceable to the diverticulum. Substernal pain was present in six cases. Dysphagia distinct from substernal pain, was experienced by six patients. Hematemesis occurred in three cases. Other minor symptoms were eructations, simple vomiting, hiccup, pain in the epigastrium, and weakness. There was no relationship between the size of the diverticulum and the occurrence of symptoms.

H A JARRE, M D

FISTULA

Chronic Pararectal Fistula Treated with X ray Therapy. Ten year Cure. Th. Nogier. *Bull et mém Soc de Radiol med de France* October, 1937, 25, 645, 646.

A persistent sinus tract which had been treated surgically for a period of over ten years was irradiated by the author with fairly heavy doses of x ray through 5 mm Al filter. A total dose of 4 800 R (Solomon) was given. The lesion has remained healed for 10 years. There is atrophy and telangiectasis of the region but the skin is supple and unbroken.

S R BEATTY, M D

FOREIGN BODIES

Unusual Foreign Body in Esophagus and Stomach. E Oppikofer Jr. *Schweiz med Wchnschr*, Jan 1 1938, 68, 26, 27.

After Tom, the Vienna "house breaking king," was arrested he tried to commit suicide by swallowing a piece of wire and 39 pins. Within the next five days 32 of the pins were evacuated but it was necessary to remove the piece of wire by esophagoscopy from its location half in the esophagus half in the stomach.

LEWIS G JACOBS, M D

GALL BLADDER (NORMAL AND PATHOLOGIC)

Newer Developments in Cholecystography. E N Collins and J C Root. *Cleveland Clin Quart* April 1937 4, 85-97. (Reprinted by permission from *British Med Jour* Aug 14 1937 page 27 of *Epitome of Current Medical Literature*.)

In an attempt to standardize procedure in the newer developments of cholecystographic examination, Collins and Root point out the following features. It has been found that the administration of multiple doses of the dye produces greater density in the visualized gall bladder than does a single dose, and it makes non-visualization of greater significance and it does not harm the patient. The administration of large amounts of sugar and other carbohydrates before and during examination facilitates the excretion of the dye by the liver. One ounce of a mixture of egg yolk, lecithin and glycerin is as efficacious in emptying the gall bladder as the fat meal. The use of pitressin in eliminating con-

fusing shadows in the intestinal tract which lies over the area of the gall bladder has precluded the necessity for re-examination. It has also made the multiple dose oral method of cholecystography possible on the same day that barium meal examinations of stomach and small intestine, or barium enema examinations of the colon are made. In a series of 1,250 cholecystographic examinations, pitressin was used in 200 cases and effective results were obtained in 87.5 per cent of these. In a more recent series in which the new ampule containing 20 pressor units was used, effective results were obtained in 90 per cent of cases. Diagnosis in these cases is usually simple when there is a history of biliary colic, especially if associated with jaundice, and it may be confirmed by cholecystography. In inflammatory diseases of the gall bladder physical examination is of assistance only during the acute or subacute stages. The authors observe that during the last five years the operative findings have coincided with the cholecystographic either positively or negatively in 95 per cent of cases.

A Probable Cause for the High Mortality Following Cholecystostomy, Cholecystogastrostomy and Cholecystoduodenostomy in Jaundiced Patients. R Russell Best and N Frederick Hicklen. *Surg*, October 1937 2, 566-574.

Operations to relieve blockage of the common duct in the face of increasing jaundice are frequently unsatisfactory and carry a high mortality rate. One cause may be the authors state, that anastomosis between the gall bladder and stomach or duodenum to relieve hepatic pressure may prove inadequate because the cystic duct may not be patent.

Probing the cystic duct or a study of the bile secretion has not proved to be reliable. Cholangiograms are used by the authors either at the time of operation or after a cholecystostomy.

If done at the time of operation the bile is aspirated and about 30-50 cc of iodized oil injected (or 48 per cent hippuran) and an x ray film made with a portable apparatus. If contrast medium is seen in the common duct a cholecystogastrostomy or cholecystoduodenostomy may be done. If none is seen, a choledochostomy or choledochoduodenostomy is indicated.

J E WHITELEATHER, M D

GENITO-URINARY TRACT (DIAGNOSIS)

Urethrography. J H Oltramare and R Martinet. *Schweiz med Wchnschr* Jan 1 1938 68, 12-25.

After a brief résumé of the methods of urethrography the authors describe their usual technique. A catheter with a balloon bulb on the tip is inserted into the meatus and inflated until tight. 40 per cent lipiodol is then injected to fill the urethra. Two films are made, one posterior and one lateral. If one avoids pain in injection no accidents are encountered.

The anatomy of the urethra is briefly reviewed. The x ray image of the normal urethra has certain fixed

lation of the thymus to status lymphaticus, and note this condition in 6 to 7 per cent of their autopsies

REPORT OF CASES

In the midst of these conflicting opinions a review was made of 88 cases, at the Los Angeles County Hospital, that carried a diagnosis of enlarged thymus. These probably do not represent all the cases and any figures given cannot be taken as exact percentage values, but they are sufficient to afford a reliable cross-section of the situation.

Of these 88 cases, 14 were children who had come to autopsy without previous roentgen examination, and the diagnosis of enlarged thymus was part of the autopsy report. It is particularly significant that all of these were cases of sudden death or of death following an acute fulminating illness of very short duration. This is in accordance with the studies of Boyd (15), who has demonstrated that the large prominent thymus and lymph nodes found in cases of sudden death, and which had been mistaken for a pathological state, are really the normal, whereas most thymuses as seen at autopsy are the involuted, inconspicuous thymuses of inanition, which had heretofore been considered normal. She found that when death occurs within from one day to one week of the onset of any disease, the weight of the thymus is moderately reduced, when death occurs one week or more after the onset, the weight is usually markedly reduced, except in persons with exophthalmic goiter or lymphatic leukemia.

The remaining 74 had roentgen examination, and of these, 54 were treated for enlarged thymus. Of the treated cases, nine (17 per cent) appeared to be improved, ten (19 per cent) have no follow up history and conclusions cannot be drawn as to the effects of the roentgen treatment. Several of those manifesting clinical improvement following roentgen treatment showed no change in the size of the thymus, when roentgenograms were taken from a few weeks to several months later. Thirty-five (65

per cent) had co-existence of other conditions which render it doubtful that thymic enlargement was the real cause of the symptoms. A large number showed complicating otitis media, sinusitis, upper respiratory infection and such conditions as allergy, congenital laryngeal stridor, congenital lues, congenital heart disease, retro-pharyngeal abscess, submaxillary abscess, bronchitis, pneumonia, whooping cough, tuberculous adenitis, prematurity, probable intracranial birth injury, and paresis.

The following are illustrative cases.

Case 1 (Fig 7) A male infant, aged three months, had been ill for about three weeks with upper respiratory infection, bilateral otitis media, and bronchopneumonia, then developing induration of the posterior pharyngeal wall. Roentgenograms taken at this time showed bulging of the retropharyngeal space probably due to abscess. They also showed broadening of the upper mediastinal silhouette, especially on the right, resembling an enlarged thymus. The symptoms cleared with incision and drainage of the abscess. Roentgen therapy was also given on the suspicion of enlarged thymus, but it is doubtful if any thymic pathology was present.

Case 2 (Fig 8) This was a five-weeks-old female infant with a history of inspiratory stridor, heavy breathing, and difficulty in swallowing for about three weeks. The films of the chest were essentially negative, but a therapeutic test with roentgen rays was given, without improvement. Later laryngoscopic examination showed congenital laryngeal stridor, which improved with cod liver oil and calcium therapy.

Mention should also be made of the question frequently raised as to possible ill effects from irradiation of the thymus in infants. In 1927, Hess (16) reported two cases of children developing Mongolian idiocy following roentgen treatment. Rowntree (17) and others have recently reported cases which had been subjected to roentgen therapy in early infancy, in which retardation, mentally or physically or both, was later found. Their work, in

quent in bilharziasis than in the normal. The implantation of cancer in these cases, therefore, seems more directly connected with calcification.

S R BEATTY M D

The Infant and Child as a Urologic Problem. E Halsell Fite. Jour Oklahoma St Med Assn, November, 1937, 30, 391-397.

The author gives the indications for a complete urinary study in children, and points out the superiority of retrograde over intravenous pyelography. Several cases are presented.

JOHN M MILES M D

GENITO-URINARY TRACT (THERAPY)

Bilateral Hydronephrosis. 12 Cases. H Smagghic. Jour urol. January 1937 43, 5-33. (Reprinted by permission from British Med Jour May 29, 1937 p 85 of Epitome of Current Medical Literature.)

The author in discussing cases of bilateral hydronephrosis, states that the condition is not uncommon and is usually revealed by intravenous urography. Bilateral hydronephrosis is met with in cases of congenital malformation in lesions of the lower urinary tract, causing obstruction in the bladder, prostate or urethra or in inflammatory lesions or tumors in the adjacent pelvic organs. These latter conditions bring about uretero-pelvic dilatation but congenital lesions of which the most common are abnormal vessels cause a dilatation of the pelvis alone. Pelvic lesions which may cause bilateral dilatation of the ureters are most often found in women and include prolapse of the uterus, uterine fibromas and ovarian cysts. Certain cases of bilateral hydronephrosis show few symptoms particularly those cases of congenital uretero-pelvic dilatation of primary origin. In other instances the dilatation causes indefinite feelings of heaviness in the lumbar region in pregnancy this symptom is hard to distinguish from muscular fatigue. In typical cases pain may be persistent or intermittent with crises similar to attacks of renal colic, affecting most severely the side on which the kidney is most damaged. The increase in size of the kidneys being bilateral may suggest

polycystic disease, but the diagnosis can be settled by pyelography.

Prognosis in cases of bilateral hydronephrosis is grave as progressive renal insufficiency leads inevitably to uremia. In pregnancy, if symptoms occur before the fourth month, the pregnancy should be interrupted. At a later stage drainage by ureteric catheters may be carried out, or in severe cases nephrostomy may be necessary. Nephropexy is indicated in all cases of simple pelvic dilatation after division of the abnormal vessel or adhesions and also when the dilatation is of uretero-pelvic origin. In cases of ineffective dilatation nephrostomy should be carried out and the kidney allowed to drain for several months. Twelve cases of hydronephrosis are reported.

GRENZ RAYS

Methods for the Marking and Adjusting of Skin Areas in Grenz ray Therapy. A Kreiner. Strahlen therapie, 1937 60, 619.

The author describes his method for adjusting skin fields in Grenz ray therapy. He uses a special focusing device which facilitates the reproduction of certain angulations. The fields are marked on the skin numbered and then photographed to allow accurate control of dosage and avoid overlapping of treated areas.

ERNST A POHLE M D Ph D

Our Experience with Grenz ray Apparatus and Dosage Meters. H Decker and J Port. Strahlentherapie 1937 59, 539.

The authors examined a number of pieces of apparatus for the production of Grenz rays including filters and also undertook a series of measurements with the dosage meters available for the calibration of such apparatus. They found a number of shortcomings in the construction of the apparatus and offer suggestions for remedying them. Some of the dosage meters showed differences as high as 25 per cent and they conclude therefore that the instruments on the market at present are not suitable for accurate measurements in the Grenz ray region.

ERNST A POHLE M D Ph D

other factors may give shadows simulating enlarged thymus

The criteria commonly given for enlarged thymus are unreliable, because of the wide range in size within apparently normal limits. In children meeting sudden death, as from accident, autopsy often reveals thymuses which would be deemed enlarged, although the children had been normal in all respects.

Even in those children presenting symptoms such as are usually attributed to enlarged thymus and in whom roentgen examination shows thymic enlargement, the great majority (65 per cent in the present series) have other causes to account for their symptoms. For this reason thorough pediatric and laryngologic examination should be made before roentgen treatment is instituted.

The propriety of a therapeutic test with roentgen rays for diagnosis must be questioned, chiefly because it may cause cessation of the search for other factors.

In view of our incomplete knowledge of the function of the thymus and because of possible deleterious effects from over-exposure to the roentgen ray, moderate dosage and extreme conservatism should be used in treatment.

Because of the uncertainty accompanying the diagnosis of enlarged thymus and the doubt that the apparently large thymus has any particular significance in symptomless children, we question whether pre-operative roentgen examination in children is either necessary or desirable unless specific symptoms or signs are present.

REFERENCES

- (1) WASSON, W. W. Thymus Gland. *Arch of Otolaryngology*, December, 1926, 4, 495-511.
- (2) FRIEDMAN, L. J. Thymus. More Recent Findings as to Function and Therapy. *RADIOLOGY*, May, 1933, 20, 380-385.
- (3) KINNEY, M. J., and TAYLOR, R. G. Observations on Eight Years' Experience in Treatment of Thymus Gland in Infants and Young Children. *Am. Jour Roentgenol and Rad Ther*, March, 1929, 21, 263-270.
- (4) PANCOAST, H. K. Roentgenology of Thymus in Infancy and Differential Diagnoses of Enlarged Thymus and its Treatment. *Am Jour Med Sci*, December, 1930, 180, 745-767.
- (5) HASLEY, C. K. Study of Motor Phenomenon of Mediastinum in Infants and Children, with Particular Reference to Hyperplasia of Thymus. *RADIOLOGY*, November, 1933, 21, 477-484.
- (6) YOUNG, M., and TURNBULL, H. M. Analysis of Data Collected by Status Lymphaticus Investigation Committee. *Jour Path and Bact*, March, 1931, 34, 213-258.
- (7) HUDSON, H. W., JR. The Thymus Superstition. *New Eng Jour Med*, May 16 1935, 212, 910-913.
- (8) KENNEDY, R. L. J. and NEW, G. B. Chronic Stridor in Childhood Sometimes Erroneously Attributed to Enlargement of Thymus. *Jour Am Med Assn*, April 18, 1931, 96, 1286-1289.
- (9) MORSE, J. L. The Thymus Obsession. *Boston Med and Surg Jour*, Feb 16, 1928, 197, 1547-1552.
- (10) WASSON, W. W. Thymic Stridor. *Jour Am Med Assn*, Sept 24 1927, 89, 1025-1028.
- (11) ABT, I. A. in discussion of above paper by W. W. Wasson. *Jour Am Med Assn*, Sept 24, 1927, 89, 1025-1028.
- (12) WALDBOTT, G. L. So-called 'Thymic Death', Pathologic Process in 34 Cases. *Am Jour Dis Child*, January 1934, 47, 41-60.
- (13) SYMMERS, DOUGLAS. Status Lymphaticus, *Am Jour Surg*, October, 1934, 26, 7-14.
- (14) GILKBY, H. M. Thymic Deaths. *Jour Missouri Med Assn*, January 1933, 30, 9-15.
- (15) BOYD, EDITH. Weight of Thymus and its Component Parts and Number of Hassall Corpuscles in Health and in Disease. *Am Jour Dis Child*, February 1936, 51, 313-335.
- (16) HESS, GEORGE H. Possible Developmental Defects Following Over-radiation of Thymus in Early Infancy. *RADIOLOGY*, December 1927, 9, 506-509.
- (17) ROWNTREE, L. G., et al. Further Studies on the Thymus and Pineal Glands. *Pa Med Jour*, May 1936, 39, 603-606.

and Lawrence, in 1924 They observed calcification of the renal veins in a case of bilateral nephrolithiasis in a female, 51 years old, who had passed small calculi for the past 20 years No other calcification was noted in the kidney

2 *Aneurysm*—A rare and bizarre type of calcification of the renal vessels is the calcification of an aneurysm of the renal artery In 1932, Mathe collected 55 cases of aneurysm of the renal artery and added one case Calcification was noted in 11 cases, to which may be added the case reported by Wesson and Fulmer (1933) Calcification may occur in either the true or false aneurysm, but most frequently in the former type The presence of calcareous deposits in the case of a true aneurysm of arteriosclerotic origin may be interpreted as part of the general calcifying process of arteriosclerosis, whereas calcification of walls of a false aneurysm is a retrogressive process due to replacement changes in the surrounding tissues which contain extravasated blood

The calcareous deposits in the walls of the aneurysm may produce an opaque ring-like shadow in the renal region on the roentgenogram, offering a difficult problem in differential diagnosis, as the condition is easily confused with shadows of a renal calculus, calcified abscess, calcified cyst, or calcified lymph node Several writers, including Key and Akerlund, Soderlund, Mathe, and Wesson and Fulmer, consider the wreath-like ring-shape shadow with a relatively denser peripheral zone to be characteristic of calcified aneurysm of the renal artery The calcified shadow is usually situated at the hilum of the kidney but occasionally is found within the kidney outline, since the aneurysmal process may involve intrarenal branches of the main artery

(E) *Injuries of the Kidney*

There is a decided paucity of reports dealing with renal calcification of traumatic origin In many of the classical articles on injuries of the kidney, no mention is made of calcification as one of the

late sequelae It is indeed very likely that many cases of calcification following kidney injuries are encountered but either are not recognized as such, being confused with calcification in other pathological renal lesions, or are not reported Colston has emphasized the etiologic rôle of trauma in the production of calcified renal and perirenal cysts

1 *Intrarenal Calcification*—The extent of calcification following kidney injuries is dependent upon the condition of the kidney before the injury, the type of kidney injury, amount of hemorrhagic extravasation, and the interval of time elapsing before the examination is made While the majority of small subcapsular hematomas and parenchymal effusions are readily absorbed, the larger collections of blood within the parenchyma or in the perirenal space are not always entirely absorbed and may undergo degenerative changes The extravasated blood in or about the kidney coagulates, clots, and adheres to the surrounding tissue and calcium salts are precipitated from the organized blood clot The site of the calcium salts may be precipitated within the parenchyma or upon the walls of a perirenal cyst Every intrarenal or extrarenal hematoma provides fertile soil for the growth of bacteria derived from a pre-existing renal lesion or distant focus of infection As a result of the infectious process, there may develop a variety of unpleasant sequelae, namely, cortical or subcapsular abscess, perirenal abscess, pyonephrosis, in any one of which calcification may occur

2 *Extrarenal Calcification* (a) *Perirenal Hematoma*—In our search of the literature, we found that the earliest reports of calcification following a kidney injury were made by Abbot in 1902 Pathological examination of the operative specimen disclosed the mass to be an old encapsulated perirenal hematoma which had undergone extensive calcification An almost similar case of calcified perirenal hematoma has been reported by Fleischer and Hansen (1935)

Sam W Donaldson, M D, 326 North Ingalls St., Ann Arbor, *Secretary-Treasurer*, E R Witwer M D, Harper Hospital Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg

132 Parkside Ave, Brooklyn Meetings first Tuesday in each month at place designated by president

Buffalo Radiological Society—*President*, John Barnes, M D, 875 Lafayette Ave, *Vice-president*, W L Mattick, M D, 290 Highland Drive, *Secretary-Treasurer*, J S Gian-Franceschi, M D 810 Niagara Street Meetings second Monday evening each month

Central New York Roentgen-ray Society—*President*, W E Achilles, M D, 60 Seneca St, Geneva, *Vice-president*, M T Powers, M D, 250 Genesee St., Utica, *Secretary-Treasurer*, Carlton F Potter, M D, 425 Waverly Ave Syracuse Meetings held in January May, and October as called by Executive Committee

Long Island Radiological Society—*President*, David E Ehrlich, M D, 27 W 86th St, New York City, *Vice president* H Kouransky, M D, 43-37 47th St Long Island City, *Secretary*, S Schenck, M D, 115 Eastern Parkway Brooklyn, *Treasurer*, Moses Goodman, M D, 45-01 Skillman Ave, Long Island City Meetings fourth Thursday evening each month at Kings County Medical Bldg

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Rochester Roentgen ray Society—*Chairman*, Joseph H Green, M D, 277 Alexander St, *Secretary*, S C Davidson, M D, 277 Alexander St Meetings at convenience of committee.

Society of Radiological Economics of New York—*President*, Albert L Voltz M D, 115-120 Myrtle Ave, Richmond Hill, *Vice-president*, M M Pomeranz M D, 911 Park Ave, New York City, *Secretary*, W F Francis, M D, *Treasurer*, Theodore West M D, United Hospital, Port Chester Meetings first Monday evening each month at McAlpin Hotel

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Radiological Society of North Carolina—*President*, Robert P Noble, M D, 127 W Hargett St, Raleigh, *Vice president*, A L Daughtridge, M D, 144 Coast Line St, Rocky Mount, *Secretary-Treasurer*, Major I Fleming M D 404 Falls Road, Rocky Mount Meetings with State meeting in May, and meeting in October

OHIO

Cleveland Radiological Society—*President*, North W

Michigan Association of Roentgenologists—*President*, E R Witwer, M D, Harper Hospital, Detroit, *Vice-president*, D W Patterson, M D, 622 Huron Street, Port Huron, *Secretary-Treasurer* C K Hasley, M D, 1429 David Whitney Bldg, Detroit

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The Kansas City Radiological Society—*President*, L G Allen, M D, 907 N 7th St, Kansas City, Mo *Secretary*, Ira H Lockwood, M D, 306 E 12th St., Kansas City Mo Meetings last Thursday of each month

The St Louis Society of Radiologists—*President* Joseph C Peden, M D, 634 N Grand Blvd, *Secretary*, W K Mueller, M D, 607 N Grand Blvd Meetings fourth Wednesday of each month

NEBRASKA

Nebraska Radiological Society—*President* E W Rowe M D 128 N 13th St, Lincoln, *Secretary*, D Arnold Dowell M D 117 S 17th St Omaha Meetings first Wednesday of each month at 6 P M in Omaha or Lincoln

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island) *President*, Frank E Wheatley, M D, 520 Beacon St Boston, *Secretary*, E C Vogt M D, 300 Longwood Ave Boston Meetings third Friday of each month from October to May inclusive, usually at Boston Medical Library

NEW HAMPSHIRE

See New England Roentgen Ray Society

NEW JERSEY

Radiological Society of New Jersey—*President* J D Tidabach, M D, 382 Springfield, Summit, *Vice-president*, Milton Friedman M D, Newark Beth Israel Hospital Newark, *Secretary*, P S Avery, M D 546 Central Ave Bound Brook Meetings at Atlantic City at time of State Medical Society and Midwinter in Newark as called by president.

NEW YORK

Brooklyn Roentgen Society—*President*, Albert Voltz M D 115-120 Myrtle Avenue, Richmond Hill, *Vice president* A L L Bell, M D Long Island College Hospital Henry Pacific, and Amity Sts

(b) *Peripelvic and Pseudo-hydronephrotic Cysts*—Wesson recently reported a case of perirenal calcification in a boy eight years old following traumatic rupture of the kidney pelvis. The extrarenal mass was a perirenal cyst or pseudo-hydronephrosis. Strauss (1931) described a case of calcification in a pyonephrotic kidney in an adult male following severe injury to the chest and back.

Case XVIII (G U 1,446), J M, male, 17 years of age, student, was admitted to Sinai Hospital on Sept 10, 1933, with a complaint of pain in the right upper quadrant. In November, 1932, he had sustained an injury to the right loin during a football game. He had hematuria lasting two days. On Sept 3, 1933, he was struck in that region during a boxing match and had a dull pain, accompanied by hematuria, lasting one day. On Sept 6, 1933, he developed a sudden stabbing pain in the right upper quadrant, radiating to the right lower quadrant and lasting several hours. This was followed by a dull pain and was accompanied by nausea, vomiting, chills, and fever. He also complained of burning, frequency, urgency, and dysuria. Physical examination disclosed fullness in the right loin and upper quadrant, with tenderness and rigidity in the same region. There were no definite masses palpable. The urine contained an occasional red blood cell and pus cell, and a stained smear showed numerous staphylococci.

Cystoscopy and pyelography on Sept 11, 1933, revealed a non-functioning kidney on the right side. A plain roentgenogram showed a large, diffuse, blotchy, calcified shadow in the upper pole of the right kidney, an oval shadow in the mid-portion, and an irregular group of calcified shadows in the lower pole (Fig 18). The pyelogram revealed the opaque medium irregularly dispersed through the entire kidney with no distinct outline of the pelvis or calices (Fig 19). A diagnosis of non-functioning calculous pyonephrosis with calcification of old blood clots was made. On Sept 14, a right nephrectomy was performed, after which the patient

made an uneventful recovery, he was discharged from the hospital on Oct 4, 1933.

Pathological examination of the operative specimen revealed an enlarged soft kidney with marked inflammatory reaction in the peripelvic and perinephritic tissues. There was a collection of old blood and pus under the capsule over the upper pole of the kidney. When the kidney was opened, about 200 c c of thick pus escaped, leaving a grumous material and organized blood clots containing calcareous material. After removing the debris, an old laceration, 1.5 cm in length, was found in the upper pole extending from the cortex to the pelvis. Microscopic examination of the tissue removed from various portions of the kidney showed typical changes associated with acute and chronic pyelonephritis.

F Renal Lithiasis

1 *Microolithiasis*—This condition may be considered as a form of calcification of the renal tubules. It is characterized by the presence of minute calculi with the lumen of the collecting tubules. It is rather surprising that this subject is not mentioned in many textbooks (Keyes, Guteras, Kelly and Burnam, Young) or in monographs on lithiasis (Joly). However, in recent years, the condition has gained some recognition, and contributions have been made by Braasch, Crabtree, Huggins, Higgins, and others.

Microolithiasis must be differentiated from the laminated deposits of uric acid (the so-called uric acid infarcts) seen in the collecting tubules of very young infants at autopsy, and from metastatic calcification of the renal tubule observed in the various bone diseases.

It is difficult to determine the actual incidence of microolithiasis, as extensive pathological and statistical studies are not available. The condition has not been described in children, probably due to the fact that histopathological studies in renal lithiasis in children are seldom made, or else the condition is not recognized. Crabtree found three instances of microolithiasis in a series of 36 nephrectomized kidneys,

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE POSITION OF RADIOLOGY IN EXPANDING MEDICAL SCIENCE¹

The citizens of the United States feel highly honored that our country has been chosen as the meeting place for 1937 of the International Congress of Radiology, an association recognized by civilized countries of the world for its achievements in advancing the social well-being of all peoples.

In this war-torn world, it is gratifying to remember that science has no country, to know that men of science from all parts of the universe, of whatever nationality, race, or creed they may be, can meet and freely discuss contributions to the welfare of mankind. Let us hope that out of such peaceful international gatherings as this, some impetus to world peace may come.

The contributions of radiology to the health and happiness of man and to social progress have been one of the wonders of our generation. Radiology has given an understanding of the intricate physical processes of health which are almost beyond the scope of the imagination, and has made possible the accurate location and diagnosis of disease in the human body.

Man's brain is the visual brain of the primates. It is true that there are other primates besides man, but they have achieved no result with the visual brain which has advanced them beyond the lower animals with the predominantly olfactory brain. In his physical make-up, man in comparison with many of the lower animals is inferior and his lifetime on earth is measured by a relatively small number of years, but his brain has given him superiority over all other animals, and the eye is the organ through which man receives his truest knowledge. It is the fact that the mind of man was built up coincidentally with the eye, and not the mechanics of the eye, that has made his intellectual progress possible. The outstanding fact in the history of medicine is that the visual method of obtaining information has always been dominant. Radiology has been a powerful factor in extending the visual method.

It might be said that what Hippocrates was to Aristotle, Harvey was to Sydenham, the great clinician (1624-1689). The observations of Hippocrates in clinical medicine furnished, in the succeeding century, a foundation for the monumental work of Aristotle in the basic sciences, as the discoveries of Harvey inspired Sydenham, "the English Hippocrates," and his contemporaries to reject dogmas and make clinical application of knowledge gained by observation.

If we review medical history from the time of Aristotle (384-322 B.C.) to the discovery of the microscope, we find that in the many centuries of the Dark Ages little progress was made in the medical sciences, although some knowledge of anatomy and physiology and clinical symptomatology was recorded. The compound microscope, the earliest crude form of which was introduced by the Janssens about 1590, was the most significant contribution of all time, which was to revolutionize medicine and change the history of mankind. This instrument opened a new scientific world and enabled the student to recognize the body tissues in health and in disease.

While the discovery of the microscope came too late to aid Harvey (1578-1657) greatly in his demonstration of the circulation of the blood, it gave a crude magnifying instrument to William Hunter (1718-1783) and John Hunter (1729-1793) and the modern microscope to Pasteur and Lister. The microscope in a relatively few years extended the breadth and the depth of understanding and developed a new anatomy of the minute and the new physiology which went with it.

With the aid of the imperfect microscope, the two brothers, William and John Hunter, co-ordinated knowledge in anatomy, physiology, and pathology so that for the first time these basic sciences became a coherent whole and medicine was placed on a sound foundation. The greatest single contribution of the Hunters was the discovery of the lymphatic system, as related to the organs and tissues of the body,

¹ Opening Address at Fifth International Congress of Radiology, Chicago, Sept. 13-17, 1937.

tubules and loops of Henle. The tubules appear dilated and the tubular epithelium and basement membrane show no evidences of calcification but present changes of an acute or chronic inflammatory nature. The microliths appear as finely granular casts having a concentric lamellar arrangement similar to that observed in larger renal calculi. They are composed of calcium phosphate or carbonate, are usually of microscopic dimensions but may attain a size of 1×0.5 mm or even larger. These microliths can readily be differentiated from the other calcium deposits of renal tubules by the fact that the latter are usually found outside the tubules, *i.e.*, beneath the basement membrane and rarely in the lumen and they never present a concentric lamellar arrangement.

Case XIX (G U 98A), A. B., male, 35 years of age, single, physician. His past history was essentially negative except for an osteomyelitis involving the lower end of the right radius and ulna at the age of five, and a non-specific epididymitis right, prostatitis, and seminal vesiculitis at the age of 29. In April, 1934, he developed hematuria which persisted for six days. He had several attacks of sharp pain in the right upper quadrant and right loin, radiating downward to the right groin. A voided specimen of urine shows 15 to 20 red blood cells and an occasional pus cell. Physical examination was essentially negative.

Cystoscopy and pyelography were performed on April 10, 1934, and revealed several groups of small calcified shadows in both kidneys. These shadows were found to be in the parenchyma of the kidney in the pyramids immediately adjacent to the tips of the calices. The patient subsequently was put on an acid-ash-producing diet with a high content of vitamin A. He received several dilatations of both ureters and passed three small stones which contained mixed phosphates. On Oct 10, 1935, he complained of sharp pain in the right kidney region accompanied by chills, fever, and hematuria. Plain roentgenogram at this time revealed an oval

shadow in the region of the pelvis of the right kidney and a calcified shadow about the size of the head of a match in the upper pole, and a smaller shadow in the lower pole of the left kidney. Following conservative treatment he had hematuria, chills, and fever which subsided. The same dietary restrictions as before were enforced. The infections of the prostate and seminal vesicles were treated at regular intervals.

On June 23, 1936, the patient had an attack of right renal colic with hematuria, and passed a small stone (about the size of a pea) and another smaller stone (about the size of the head of a match). In March, 1937, a left nephrolithotomy was performed and a large stone removed.

2 Cortical Stones—These stones are of two types: partially or completely encysted. It is generally recognized that the majority of the cortical stones are of the partially encysted variety. In this type the dilated terminal portion of the minor calyx containing the stone usually retains its connection with the major calyx and pelvis, despite the fibrous or cicatricial changes, and the formation of the stone is governed by the usual factors concerned in the formation of renal calculi.

In the completely encysted type of cortical stone, cyst formation may be primary and stone formation secondary. The cyst formation may be due to a variety of lesions, (a) occlusion of a minor calyx by chronic inflammatory changes in and about the terminal calyx, (b) cystic degeneration following trauma or intrarenal hemorrhage, (c) cystic degeneration of the parenchyma as a result of a vascular occlusive phenomenon, (d) cystic degeneration within the parenchyma, especially the cortex, as a result of an acute or chronic infection, *i.e.*, chronic pyelonephritis, localized circumscribed abscess, (e) cystic disease, *i.e.*, congenital polycystic type, simple serous or hemorrhagic cysts. Stone formation may occur within any of these cysts as a result of degenerative changes and in many instances it may be accompanied by or be secondary to cal-

a new conception of invisible rays almost beyond the comprehension of man

And now came the phenomenal discoveries, by most convincing original work, to which the world owes a debt of gratitude. Crookes (1832-1919) was the last of the great all-round physicists. He gave the fundamental knowledge of the cathode rays, the basic conception of the x-rays. Roentgen was working with Crookes' tubes when he discovered the x-rays, in 1895. The Curies discovered radium in 1898. Through the application of the x-rays and radium, knowledge of radiology was advanced with extraordinary speed, all the related sciences of medicine and of surgery progressed rapidly with the aid of the new instruments of precision connected with radiology, and by means of new forms of photography, ultra-microscopic phenomena were made visible to the eye.

Because of the extraordinary development which has come from radiology, we not only are able to bring knowledge to the brain of man, but have learned that the x-rays, beta rays, and gamma rays have an enormous and growing therapeutic value. New rays of vast extent of which we are just beginning to be conscious are demonstrated, and there is developing an entirely new theory of rays which in its scope and complexity appeals to the mind of man and opens a new understanding of science. As a result, medicine and surgery find themselves fortified by relatively new agents which day by day are being used increasingly in the treatment of disease. We recognize that in certain situations advanced cancer, which is beyond reasonable possibility of cure by the knife, can with but little risk be treated with radiant energy in the form of x-rays and radium, and even cured, if it has not progressed beyond the immediate site. We find that certain cellular tumors which are extremely active in growth can be treated with radiology with better results than with surgery, and without serious risk. This new agent, which began as an aid to surgery and medicine, extends its usefulness day by day.

From the period of the unaided eye, through the era of the development of the microscope and its revolution of scientific medicine, we have entered, through radiology, into another epoch of scientific achievement not only in medicine and in the allied fields, but in universal science.

Let us think for a moment of the science of

astronomy, which challenges the imagination of man, unbelievable were it not that it proves the correctness of its premises. Just as the microscope and radiology have carried knowledge into the minute, so have the giant telescopes carried the eye into the heavens. Let us be thankful that power has been given to the brain of man through the eye to understand and appreciate these extraordinary discoveries, for the two closely related manifestations of radiant energy, radiology and astronomy, have been brought through photography within the comprehension of all the people, the layman as well as the scientist.

In the name of organized medicine, I bid you welcome to the United States, and I pay homage to science, in which radiology is establishing a new leadership.

WILLIAM J. MAYO, M.D.

Rochester, Minn.

ANNOUNCEMENTS

NEXT ANNUAL MEETING

The next Annual Meeting of the Radiological Society of North America will be held at Pittsburgh, Pa., at the Hotel William Penn, November 27-December 2, 1938.

CHICAGO TUMOR INSTITUTE

March 21, 1938, marked the opening of the Chicago Tumor Institute which will offer consultation service to physicians in the diagnosis and treatment of cancer, and radiation facilities for cancer patients. The Institute is a corporation not for profit which proposes to conduct research and to offer training to physicians who may wish to qualify as specialists in the study and treatment of cancer.

The Board of Trustees is as follows: Ludvig Hektoen, M.D., *President*, Arthur H. Compton, Ph.D., *Vice-president*, Roy G. Osgood, *Treasurer*, M. J. Spiegel, Mrs. Francis Neilson, Mrs. Arthur Meeker, Alfred Busiel, and Max Cutler, M.D.

The Scientific Committee is composed of the following members: Max Cutler, M.D., *Director*, Sir G. Lenthal Cheatle, F.R.C.S., of London, Henri Coutard, M.D., formerly of Paris, France, Arthur H. Compton, Ph.D., of the University of Chicago, winner of the 1927 No-

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rado from November, 1921, to July, 1923. In January, 1924, he married Matilda Branstetter. They had two children: Jane, born in November, 1926, and Guy, born in January, 1928. In Denver, Dr. Withers limited his prac-

New York State Institute for the Study of Malignant Diseases and had visited all the centers for the treatment of malignant disease in the United States.

In September, 1937, Dr. Withers installed



The late Sanford Withers, M.D., long an honored member of the Radiological Society of North America.

tice to radiology. He served as Radiologist to the Denver General Hospital from 1926, and as Radiation Therapist to Beth Israel Hospital, Denver, from 1928. Beside his hospital duties and his private practice in the years succeeding 1922, he conducted private courses in the use of radium and x-ray in the treatment of neoplastic diseases. Over 300 physicians took these courses. To equip himself to teach, beside his previous training and constant study, he had taken a course at the

400,000-volt roentgen therapeutic equipment, and in October he began to notice evidence of aplastic anemia. This became progressively worse in spite of remedial and therapeutic care, and shortly after the first of the year, 1938, he went to New York City. He died there on March 8, 1938, of aplastic anemia with a terminal bronchopneumonia.

Dr. Withers was a member of the staff of Mercy Hospital (Denver), Presbyterian Hospital (Denver), St. Luke's Hospital (Denver),

putty like bodies depend upon the amount of calcium present. The shadows of semicalcareous bodies may be easily confused with true renal calculi containing a mini-



Fig 22 Case XXI. A plain roentgenogram showing an enormous enlargement of the right kidney containing several large stones (C) surrounded by myriads of small pinhead-sized calcified shadows (B). In the right ureter below the sacroiliac joint there is a large oval shadow (A) which on close inspection appears to be a conglomeration of small calcified bodies. There are several large stones in the left kidney (D).

mum amount of calcium salts or with the irregular or spotty areas in renal tuberculosis or neoplasms. A pyelogram may be of value in the diagnosis of these putty-like bodies. The non-radiable type may produce filling defects in the outline of the pelvis or calyx, while the radiable type presents a softer shadow which stands out in contrast to the dense shadow of the opaque pyelographic medium.

These putty-like bodies must not be confused with the so-called "putty kidney" known as "*degenerescence massive du rein* of Tuffier," which is considered a pronounced form of occluded renal tuberculosis with massive destruction and calcification of the kidney.

4. *Sandy Material*—The presence of loose granular material in the pelvis or calices is not an infrequent finding at

autopsy, or at operation for lithiasis. In such cases, it is difficult to state whether the sandy material is due to the granular disintegration of a soft or loosely constructed stone or represents the early stage in the formation of an organized stone. The presence of larger particles in the infected cases of renal lithiasis, as in the authors' case, apparently is due to calcification of the purulent necrotic debris which accumulates within the pelvis or calices as a result of stasis and obstruction. The size of the individual granules varies from fine dust-like substance to pellets resembling caviar or small buckshot. These granular particles contain a varying amount of organic and inorganic salts and consequently produce bizarre shadows or irregular density in the roentgenogram.

Case XXI. H. W., male, 52 years of age, married, clerk, was admitted to the Church Home and Infirmary on the service of Dr. Amos F. Hutchins, to whom we are greatly indebted for the permission and courtesy of reporting this case. The patient's chief complaint was pain in the right upper quadrant and right lumbar region. He had his first attack of right renal colic six years before, four years before he developed a dull sticking pain in the right upper quadrant, for the past six months he had also complained of sharp pain in the penis on voiding, frequency, nocturia, urgency, and tenesmus. On several occasions in the past four years he has had hematuria.

The positive findings on examination were a marked loss of subcutaneous fat, a left hydrocele, and a mass in the right upper quadrant. The mass was about the size of a man's head, and was tender. The urine gave a positive test for albumin (3 plus) and microscopically showed 15 to 20 pus cells, an occasional red blood cell, and many triple phosphate crystals. On admission, the blood NPN was 125 mgm per 100 c.c., the blood urea 87.40 mgm, blood creatinine 212 mgm. These tests were repeated at intervals of from three to four days and showed a slight but definite increase of the various nitrogenous

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Abnormalities	655	Contrast Media	660
Animal Experimentation	655	The Cranium	660
Apparatus	655	Deficiency Disease	661
Arthritis	655	Diathermy	661
The Bladder	656	Diphtheria Carriers	661
The Blood	656	Dosage	661
Bone Diseases (Diagnosis)	656	Esophagus	662
Bone Diseases (Therapy)	657	Fistula	664
Breast Cancer	658	Foreign Bodies	664
Cancer (Diagnosis)	658	Gall Bladder (Normal and Pathologic)	664
Cancer (Therapy)	658	Genito-urinary Tract (Diagnosis)	664
The Chest	659	Genito-urinary Tract (Therapy)	666
Colitis	660	Grenz Rays	666

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S M ATKINS, M D , of Waterbury Conn	JOHN M MILES, M D , of Houston, Texas
S R BEATTY, M D , of Madison, Wis	L W PAUL M D of Kansas City, Mo
HANS W HEFKE, M D , of Milwaukee Wis	ERNST A POHLE, M D , Ph D , of Madison Wis
LEWIS G JACOBS, M D of Madison Wis	J C RODICK, M D , of New Orleans, La
H A JARRE M D of Detroit, Mich	W A SODEMAN, M D of New Orleans, La
A MAYORAL, M D of New Orleans, La	WILLIAM R STECHER, M D , of Easton, Pa
J E WHITELEATHER, M D , of Memphis, Tenn	

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

ADLER, S <i>with</i> MOEHLIG, R C jt auth	657	FREY E K and DUSCHL L Cardiospasm	663
ALFRED-LÉVI, M Intracranial Projectiles	660	GLASSER, OTTO Dosage Measurements on Ten 400-kilovolt Roentgen ray Generators	661
ALLEN M LOWRY and JOHN RUTHERFORD L Osteitis Deformans (Paget's Disease) Fissure Fractures—Their Etiology and Clinical Significance	657	Idem Roentgen Therapy with Supervoltage in North America	662
BARKER W H, <i>with</i> MILLER, D K jt auth	661	GUILLAMET, M L Several Cases of Gonococcal Arthritis Treated by X ray	656
BAUER, J and JUNG A Fibrocystic Disease and Hyperparathyroidism	656	GUTMANN, M R A Extensive 'Radiologic' Defects Corresponding to Cancers Not Found by the Surgeon	658
BERNARD JACQUES <i>with</i> THOYER ROZAT P jt auth	660	HERMETO, SEBASTIÃO JR A Clinical Pathological Contribution to the Study of Osgood-Schlatter's Disease	657
BEST R RUSSELL and HICKEN N FREDERICK A Probable Cause for the High Mortality Following Cholecystostomy, Cholecystogastrostomy and Cholecystoduodenostomy in Jaundiced Patients	664	HICKEN N FREDERICK <i>with</i> BEST R RUSSELL jt auth	664
BORAK, J The Biological Principles of Radiation Therapy of Malignant Tumors with Fractional Doses	658	HIRSCH J J The Determination of the Dose in Radium Therapy of Carcinoma of the Cervix	661
COLLINS E N and ROOT J C Newer Developments in Cholecystography	664	HOLFELDER, H Indications for X ray Therapy	658
CORRIGAN K E <i>with</i> LEUCUTIA T jt auth	662	HOOVER W B <i>with</i> LAHEY F H jt auth	663
COSSIO P and TRIMANI A Triangular Parapevian Shadow	659	JOHN, RUTHERFORD L <i>with</i> ALLEN M LOWRY, jt auth	657
DECKER H and PORT J Our Experience with Grenz ray Apparatus and Dosage Meters	666	JÖNSSON, GUNNAR Notes on the Roentgen Picture of the So-called Esophagus of the Lip	663
DILLHERR and PROUVAZ CH The Reconstruction of Anatomical Planes by Means of Radiography The Biotomic and Phototome of Bocage	655	JUNG A <i>with</i> BAUER J jt auth	656
DELOUMIER ALFRED A Roentgen Therapy in Acute Pararthritis	656	KEITH, N M and OSTERBERG A E Acute Bismuth Poisoning, with Recovery	660
DENIER ANDRÉ Certain Conclusions from Study of Radiation of 200-400 Kilovolts with the Photoelectric Cell	662	KOPELOWITZ JONAS C A Review of Idiopathic Ulcerative Colitis with Report of Five Cases	660
DUSCHL L <i>with</i> FREY E K jt auth	663	KREINER A Methods for the Marking and Adjusting of Skin Areas in Grenz ray Therapy	666
FRICHSEN I Intravaginal X ray Treatment	659	KLENTZ <i>with</i> LAQUIERRE, jt auth	661
LITTLE I HALSHELL The Infant and Child as a Urologic Problem	666	KUNATH CARL A Carcinoma of the Male Breast	658
		LACASSAGNE A The Histological Changes in the Infectious Papilloma of the Rabbit	

thrombosis We have observed a case of calcification of the kidney, secondary to a carcinoma of the sigmoid, in a patient who had urinary changes suggestive of a chronic nephritis

Case XXII (Med 14,383), S S, male, 72 years of age, married, retired tailor, was admitted to the medical service of the Sinai Hospital on Dec 31, 1936 He had been troubled with chronic constipation for more than twenty years but for the past two weeks he had complained of six to eight watery stools daily, often colored with fresh blood He also complained of recent loss of weight, anusea, and anorexia Physical examination was essentially negative The laboratory studies revealed a marked degree of anemia The urine showed a trace of albumin, and microscopically contained granular and hyaline casts, and red blood cells The patient's condition was too precarious to permit a barium enema, he died on Jan 8, 1937 An autopsy, performed six hours after death, revealed a large fungating carcinoma of the sigmoid, with perforation and involvement of an adjacent loop of ileum The left kidney showed an extensive calcareous papillitis of pyramids in the lower pole of the kidney

(C) *Cirrhosis*—In a series of 507 autopsies, Goldschmidt (1913) found calcium deposits present in 44 cases of cirrhosis of the liver, absent in four cases of cirrhosis, and in other diseases in only three cases

(D) *Dysentery*—Schmidt (1920) reported a case of extensive calcification of the kidneys, observed at autopsy of a soldier 37 years of age, who had died from heart failure during an attack of infectious dysentery The renal calcification was superimposed upon a grave lesion of the epithelium of the renal tubules The author was of the opinion that the degenerative renal lesion in this case was not the direct result of the infectious dysentery and referred to other probable etiological factors, namely, cardiovascular disease and the use of betanaphthol as a skin ointment He believed that the betanaphthol, which is a well known renal poison, undoubtedly

increased the effect of the infection upon the kidney He also noted that the degeneration and necrosis of the renal tubules in this case did not differ from the findings in grave cases of sepsis or typhoid fever in which no calcification occurs He maintained that the specific factor responsible for development of calcification of the damaged renal epithelia in one disease and not in the other is the lesion of the colonic mucosa, which results in a disturbance of calcium excretion in the large bowel and of calcium elimination through the kidney

(E) *Undetermined Type of Gastro-intestinal Diseases*—Butler, Wilson, and Farber (1936) reported the presence of deposits of calcium salts within and adjacent to the collecting tubules of the renal pyramids in four infants and one child, who presented what they considered to be a new clinical syndrome The important clinical features were (1) persistent dehydration in the absence of excessive diarrhea and vomiting and in the presence of adequate food, salt, and fluid intake, and (2) a persistent hypernea, associated with a sustained elevation of serum chloride concentration and reduction of serum bicarbonate content No evidence of hyperparathyroidism was found in any of the cases It is rather striking that each patient gave a history of an acute upper respiratory disease at the onset of the illness and died of a terminal pneumonia It is possible that incipient renal lesions developed during the course of the acute upper respiratory disease and, as the disease progressed, more extensive changes, including calcification of the tubules, occurred in the kidneys

In each of the aforementioned alimentary diseases, it appears that the calcification of the renal tubules is the result of a disturbance in the excretion of calcium, in contradistinction to the type of calcification observed in bichloride of mercury or other metallic poisoning, in which the calcification is secondary to necrosis of the cells, especially of the convoluted tubules The calcium salts are deposited between the tubular epithelium and the basement

ABNORMALITIES

Anomalies of the Ribs in Childhood Stefan Simon. *Röntgenpraxis*, January, 1938, 10, 45-50

Since roentgenograms of the chest have been used more or less routinely for the diagnosis of diseases of the lung in children, anomalies of the ribs have been found rather frequently. They may be demonstrated in from 2 to 3 per cent of all children. They consist mostly of bony bridges between two ribs, of a fork-like deformity of their anterior ends, or of anomalous bony processes at some point of the ribs

HANS W. HBFKE, M D

ANIMAL EXPERIMENTATION

The Histological Changes in the Infectious Papilloma of the Rabbit during the Healing Stage Following Roentgen Irradiation A Lacassagne *Strahlentherapie*, 1937, 60, 290

The infectious papilloma of the rabbit was discovered by R. E. Shope, in 1933, and has been used since for radiobiological investigations. The author studied its response to roentgen rays (180 kv 5 ma, 30 cm FSD, 1 mm Cu + 3 mm Al, 12 cm² field size, exposure for one and one half hours, dose 3,000 r). The infectious papilloma healed completely in a few days following this treatment. It appeared that the abnormal epithelial cells show a higher susceptibility to irradiation than the normal cells of the epidermis from which they originate. The reparative process is very similar to that observed by the author in irradiated epithelioma in man.

ERNST A. POHLE, M D, Ph D

APPARATUS

The Reconstruction of Anatomical Planes by Means of Radiography The "Biotome" and 'Phototome' of Bocage. Delherm and Ch. Proux *Bull et mém Soc de Radiol méd de France*, October, 1937, 25, 608-611

The authors discuss the various methods of planigraphy and the problem of radioscopy of a plane giving credit to Bocage for his work in these fields. Brief descriptions of a new apparatus for fluoroscopy and of one for radiography of images in one plane are given.

S R BEATTY, M D

Radioscopy of a Plane of the Body Its Value and Practical Realization P. Pontus *Bull et mém Soc de Radiol méd de France*, October, 1937, 25, 603-605

The author describes a method for radioscopic visualization of a single plane of the body which he has found experimentally practical. The method depends on the synchronization of a circular movement of the tube and of an optical system of two mirrors, at 45° angles to the screen which scan the moving image on the fluorescent screen and produce the illusion of a stationary image of a single plane of the body. The center

of the optical system is fixed to rotate about the axis of rotation of the tube. The author states that in selecting a given plane the experimental apparatus is accurate to within 5 mm. There are certain advantages to radioscopy over radiologic methods, particularly in that the chosen plane can be easily selected. The method would be of considerable value also as an adjunct to radiologic methods in selecting the levels of the planes to be studied.

S R BEATTY, M D

Stratigraphy of the Lung by the Method of Vallebona. Presentation of an Apparatus for Stratigraphy, the Oscillo-strator G. Ronneaux and J. M. Lemoine *Bull et mém Soc de Radiol méd de France*, October 1937, 25, 592-599

The authors present their apparatus for stratigraphy of the chest built according to the principle suggested by Vallebona. The tube is fixed at a distance of 1 meter and 90 cm. The film and the patient are rotated simultaneously through 20-30° of an arc during exposure. The authors obtained results equal to those obtained by other methods of planigraphy in use and they believe that their method has the advantage of simplicity. The apparatus is described in some detail.

S R BEATTY, M D

The Problem of Roentgen Dosage by Means of Photometry of Fluorescent Screens A. Langer and J. Sprindrich *Strahlentherapie*, 1937, 59, 680

The authors discuss the use of fluorescent screens in roentgen-ray dosimetry, a principle which was used first by Wintz and Rump. In connection with a photoelectric cell of special construction this method may have promising possibilities.

ERNST A. POHLE, M D, Ph D

ARTHRITIS

So-called Arthritis Mutilans J. Schüller *München med. Wchnschr.*, Aug 27, 1937, 55, 1381-1386

An excellent review of the present status of this entity is presented and six cases are reported. The diagnosis is readily established roentgenographically and the etiology is amply discussed. This condition is not uncommonly observed in association with psoriasis, and may actually precede the manifestations of psoriasis a few years. When psoriasis is considered the etiologic factor then the appellation 'arthropathia psoriatica' is appropriate. There are different forms, varying from simulants of infectious arthritis, periarthritis endocrina destruens, to osteo-arthritis deformans. It is not unusual for a concomitant history of 'rheumatic pain' to be present in the early stage of development. The author is strongly of the opinion that mono- or poly-arthritis mutilans is definitely resultant of a neurologic lesion, even though a myelodysplasia may not be demonstrable. One case is mentioned in which both the symptomatology and roentgen findings strongly simu-

and influence its deposition in the kidney. Further support of this premise is found in the report of Butler, in 1924, who pointed out that hypercalcemia may also occur in leukemia.

We have observed a case of chronic lymphoid leukemia, accompanied by a large calculus, and diffuse calcification of the parenchyma of the right kidney, in a patient who had no roentgen therapy prior to diagnosis.

Case XXIII (Med 91,287), R. L., female, 50 years of age, married, housewife, was admitted to the medical service of Sinai Hospital on May 5, 1937. Her chief complaint was pain in the left side of the neck, left shoulder, and left arm, for the past ten years. In the past five years she has had a chronic productive cough which was preceded by an attack of pleurisy. In the past month, she has had pain in her right kidney region and periodic attacks of hematuria.

Physical examination disclosed an enlarged spleen, general glandular enlargement, general arteriosclerosis, and chronic bronchiectasis. The leukocyte count varied between 50,000 and 84,000, and the smears showed 80-84 per cent small lymphocytes. A diagnosis of chronic lymphoid leukemia was made. The urine showed an occasional trace of albumin and many red blood cells. Intravenous urographic studies revealed a large triangular shadow in the region of the pelvis of the right kidney, with diffusely scattered patches of calcification in the cortical area of the same kidney (Fig. 23). The patient was discharged from the hospital on May 17, 1937, after which she received intensive deep roentgen-ray therapy, but succumbed in the Fall of 1937.

(B) *Senile Type* —The age incidence was studied by Beer in 1904, and by Openheimer in 1923. Beer reviewed 100 autopsies and found calcium deposits in 53 cases. He stated that microscopic deposits are practically always found in old age, whereas such deposits are invariably absent in young individuals. At age 25 to 35, there is a gradual shift from the

pains in the left thigh, and both hips were treated by roentgen therapy with no result. There was a history of an early fracture of the right radius which had left a deformity, although function was good. Menstruation had not begun until the age of 20, and had now ceased. The patient was married, but she had no children. Radiological examination showed a generalized osteoporosis and the presence of numerous areas of bone absorption. These appearances suggested that the patient was suffering from generalized fibrocystic osteitis. Roentgenography showed the characteristics of fibrocystic disease and laboratory tests confirmed this diagnosis. Although no parathyroid tumor could be seen or felt, it was assumed that there was one, and operation revealed a large adenoma in the region of the right inferior thyroid artery, which was removed. Pain disappeared after operation, but a spontaneous fracture occurred in the left femur and was put up in extension. The day after the operation the sign of Chvostek was seen, first on the left side of the face, then on the right and there was paresthesia in the arms and leg. Gluconate of calcium was given intravenously and by the mouth. A typical attack of tetany developed, and there was a sudden alteration in the blood calcium content, which fell to 70 mg the day after operation. Ammonium chloride was then given, and later a coffee of gluconate of calcium. The condition of the patient gradually improved and the fracture united satisfactorily. The authors consider that this case illustrates the influence of the parathyroid hormone on the osteoclastic resorption of bone.

Osteitis Deformans (Paget's Disease). Fissure Fractures—Their Etiology and Clinical Significance. M. Lowry Allen and Rutherford L. John. *Am Jour Roentgenol and Rad Ther*, July, 1937, 38, 109-115.

Incomplete fissure fractures occur on the convex surface of the curved long bones of Paget's disease, particularly the femur and tibia. These follow slight trauma, since the bone is brittle. They heal with a minimum amount of bony callus which assumes the characteristics of the dominant Paget's disease. Additional slight trauma may result in complete fracture and, therefore, in patients with this disease one should be on the alert for fractures, which manifest themselves by sudden pain and a distinct persistent localized tenderness. Suitable splinting or bracing with rest, should be instituted immediately.

S. M. ATKINS, M.D.

Carbohydrate Metabolism Disturbance in Osteoporosis and Paget's Disease. R. C. Moehlig and S. Adler. *Surg Gynec. and Obst.*, April 1937, 64, 747-757.

These authors call attention to several points of similarity between osteoporosis and Paget's disease, namely: diabetic type of glucose tolerance curve, and high incidence of familial diabetes, familial obesity and familial tallness. They attach great importance

to this fact, since phosphorus compounds are essential to proper storage and utilization of carbohydrate. The controlling link between carbohydrate utilization and phosphorus lies in the pituitary gland, and therefore osteoporosis and Paget's disease have their etiology in some derangement of pituitary function. Evidence is given to substantiate the claim that the parathyroids do not participate in these two diseases. The authors also draw attention to the high incidence of goiter, fibroids, nephrolithiasis, and soft tissue calcifications including arteriosclerosis in patients suffering from osteoporosis or Paget's disease. In the treatment of these diseases, the authors recommend a measured diabetic diet together with the use of insulin, for long periods of time. Theelin injections have been used in an effort to check the activity of the pituitary gland, but with no success. Finally, they urge that dextrose tolerance and phosphatase studies be performed routinely in bone diseases.

H. A. JARRE, M.D.

A Clinical Pathological Contribution to the Study of Osgood-Schlatter's Disease. Sebastião Hermeto Jr. *Annaes Paulistas de Medicina e Cirurgia*, September 1937, 34, 199-214.

The writer makes an extensive and rather complete histological study of two extirpated tibial tubercles. He states the symptoms of the condition known as Osgood-Schlatter's disease, the x-ray findings, and suggests treatment.

He recalls that Osgood, of Boston, and Schlatter, of Berlin, described the condition simultaneously in 1903. Both believed it to be traumatic in origin, the latter calling it a "fracture by traction" while Alsborg, in 1908, considered it to be inflammatory, and called it an "apophysitis." Axhausen believes it is an aseptic necrosis of the epiphysis and suggests a common origin for this condition, Calvé-Legg-Perthes disease, Köhler and König disease.

To have a clear concept of the affection, knowledge of the development of the tibial tubercle is imperative. The work of Fromme, Müller, and Schultze, which showed the influence of disturbances of growth in anomalies of ossification is cited and followed by the study of tissue slides made from two extirpated anterior tubercles presenting the affection known as Osgood-Schlatter's disease. After describing in detail the findings, the following conclusion is reached: Osgood-Schlatter's disease is an abnormal ossification of the tibial tuberosity—the abnormality usually assuming increased ossification of the cartilaginous process that projects into the insertion of the quadriceps tendon.

A. MAYORAL, M.D.

BONE DISEASES (THERAPY)

Roentgen Therapy of Benign Bone Disease. W. Lahm. *Strahlentherapie*, 1937, 60, 631.

The author discusses briefly his experience in the



Fig 23 Case XXIII A plain roentgenogram showing the large triangular shadow of a stone in the pelvis of the right kidney and several small calcified areas in the cortical area

zones This was confirmed by histological study, which revealed calcium salts in the lumen and replacing the epithelium of the distal convoluted and straight collecting tubules He failed to find any evidences of calcification in 25 other leukemics not treated by roentgen ray He also studied the experimental effect of the roentgen ray on the kidneys of rabbits and mice, but was unable to produce calcification Verse (1910) described a case of myelogenous leukemia in which calcification of the kidney was limited to a few areas in the cortex Numerous tubules showed calcified masses in the lumen The glomeruli and arteries showed no calcification Wells (1915) reported a case of myelogenous leukemia which showed calcification in the kidney as well as in the endocardium, pulmonary veins, and cardiac arteries It is possible that the disease produced toxic changes in the kidney of an indeterminate nature which may interfere with the excretion of calcium from the kidney

The proportion of recurrences in these cases was only 20 per cent. Of cases of inoperable carcinoma of the breast treated with x rays 40 per cent were alive after three years, and 36 per cent after five years. Prophylactic post operative irradiation considerably improved the operative results, 68 per cent of cases treated in this way were alive after three years and 54 per cent after five years. Untreated bronchial carcinoma practically always proves fatal but three cases treated with x rays were alive after seven, six, and four and a half years respectively. Similar results were obtained in cases of carcinoma of the esophagus in the treatment of which the author prefers x rays to intra-esophageal applications of radium. X ray treatment cured 55 per cent of cases of inoperable carcinoma of the stomach, and an improvement was effected in 42 per cent of all the cases treated. In lymphogranulomatosis x ray treatment considerably retarded the inevitable fatal issue. In pituitary tumors a clinical cure was obtained in 50 per cent of cases, and the author thinks that in spite of the excellent operative results treatment by irradiation is preferable in these cases. A five-year cure in cases of osteogenic sarcomas was obtained in 23 per cent of cases by x rays alone and in 31 per cent by combined surgical and radiological treatment. The author stresses the importance of the collaboration between surgeon and radiologist in the treatment of malignant growths.

Six and One half Years' Experience in Cancer Therapy with Ultra hard Roentgen Rays. E. v. Schubert. *Strahlentherapie* 1938 61, 97.

This is a brief report of the author's experience with 600 kv. roentgen rays in the treatment of 194 cases of malignant tumors seen from 1930 to 1935. He used a focal skin distance of 94 cm. 1.5 ma. 3.0 mm. Cu. + 3.0 mm. Al which delivered 3-4 r/min. The total treatment was concentrated on two or three days with daily sittings lasting four or five hours. The distribution of the radiant energy within the pelvis and the efficacy of intra uterine radium application as a supplementary method are discussed. An analysis of the cases indicates that supervoltage therapy with massive doses given within a few days leads to better results than exposure to a larger number of fractional doses. The author recommends 2,000 r (in air) given over two large fields within two days. The results with higher doses are less favorable. It is concluded that roentgen therapy with from 400 to 500 kv. has so many advantages that its general acceptance and use seem desirable.

ERNST A. POHLE, M.D., Ph.D.

Intravaginal X ray Treatment. F. Erichsen. *Zentralbl. f. Gynäk.* June 5 1937 61, 1330-1335. (Reprinted by permission from *British Med. Jour.* July 31 1937 page 19 of *Epitome of Current Medical Literature*.)

The author is satisfied that he has had better results in the treatment of inoperable cervical carcinoma since

he introduced, six years ago, a supplementary x-ray treatment by a Schaefer Witte tube introduced into the vagina. Primary parametrial or secondary pelvic wall deposits are thus more accessible, and in contrast to radium treatment the use of a very high irradiation dosage is compatible with the protection of neighboring healthy tissues. The general scheme of treatment is (1) radium 4,000 to 5,000 mg. hr. being given, (2) percutaneous x radiation 1,800 r being applied from four to six front, back, and side fields, and 800 r from a perineal field, this is alternated with (3) 1,600 to 2,000 r at a depth of 5 cm. directed to the right and left pelvic walls from the intravaginal water-cooled tube. Increase beyond the last named dose is useless if not harmful and the whole treatment occupies about 40 days. Disturbances of rectal and vesical function may follow but no fistulae developed, the lateral vaginal walls showed transitory appearances of membranous inflammation. In inoperable (Groups III and IV) patients thus treated, 38 per cent were living and symptom free from one and a half to four years later, as well as three out of 12 patients who were treated for local recurrences.

Radiation Therapy in Advanced Malignant Disease. E. A. Pohle. *Strahlentherapie* 1938 61 233.

'The value of radiation therapy in advanced malignant disease is not sufficiently appreciated, it not only offers palliation in many instances, but occasionally one experiences surprisingly good end results. Since there is no way of predicting which case will respond to radiation it should be tried wherever possible even in relatively hopeless cases. A brief report is made of a series of cases selected at random to illustrate the author's experience in treating advanced malignant neoplasms by roentgen rays. Although the patients discussed here have received only this type of radiation, it is emphasized that radium also has its place in this field. Other radiologists are urged to publish similar material which has come under their observation.'

AUTHOR

THE CHEST

Triangular Para apexian Shadow. P. Cossio and A. Trimani. *Revista Argentina de Cardiologia* July-August 1937 4, 157-169.

After discussing the causes assigned by other workers for the triangular shadows occasionally observed in the cardiophrenic angles in roentgenograms of the thorax the authors report their findings and conclusions based on the study of teleroentgenograms and orthodiagrams made of the chests of 3,968 individuals and anatomical observations postmortem of 20 specimens.

In this material the para apexian shadow was found 57 times, mostly in the male and not once in an individual below the age of thirty. Roughly 75 per cent of the persons in whom the sign was found were of the lean or normal weight type. In 78 per cent some car-

rabbits in whom a high ligation of the ureter was performed, as well as ligation of the vascular pedicle

Each of the foregoing investigators stressed the amount of blood supply as a primary factor in pathological ossification of the kidney. Although Liek stated that the presence of young connective tissue near the site of calcium deposits was a necessary requirement for bone formation, and commented upon the relation of bone to the persistence of pelvic epithelium, he did not associate the latter two factors.

Pearce (1909) observed bone formation following excision of the lower pole (approximately one-half) of the kidney, with suture, in six of 19 rabbits' kidneys. He attributed the bone to a metaplasia of connective tissue associated with a proliferation of the epithelium of the pelvic mucosa. The metaplasia of the connective tissue into bone was studied from a histogenetic standpoint by Asami and Dock (1920). They found that ossification occurred in the loose connective tissue beneath the pelvic and calycial epithelium independently of calcification of the parenchyma. They concluded that ossification following ligation of renal pedicle occurred as a result of (a) activity of young fibroblasts beneath pelvic epithelium which accumulated to form a membrane-like structure resembling periosteum, (b) direct ossification of hyaline connective tissue in continuity with prepared bone, and (c) erosion of lime plaques and laying down of lamellar bone by cells derived from fibroblasts. Huggins (1930) demonstrated the osteogenic properties of the epithelium of the renal pelvis, which he maintained was the primary factor in the formation of bone following the ligation of the renal pedicle. He also observed bone formation beneath pelvic mucosa following fulguration of the renal pelvis with electric current of high frequency in two of three dogs, and following application of 95 per cent phenol to the pelvic mucosa in one dog. Huggins attributed the osteogenetic process to a metaplasia of the connective tissue directly into bone as a result of the influence of newly formed

proliferating epithelium of the pelvic mucosa.

The unusual osteogenic properties of the tissues of the urinary tract was first demonstrated experimentally by Strauss. He studied the repair of ureteral defects in dogs by transplanting pedunculated flaps of tissue from the abdominal walls, which consisted of transversalis muscle, fascia, and peritoneum, and found that in every instance a layer of bone formed in that portion bordering on the lumen of the ureter, converting the ureter into a rigid tube. Neuhof repaired defects in the bladder of dogs by transplanting strips of fascia lata and found ossification of that portion of the graft bordering on the lumen of the bladder. Calcification appeared six days and ossification 17 days after operation. Beyond this date, an epithelial lining grew in from the margins and covered the bony surfaces. In neither Strauss' nor Neuhof's experiment was there any associated stone formation by encrustation of the bony surface. The calcified and ossified flaps were attributed to the deposition of calcium salts in the necrotic tissues of the fascial patches in contact with the acid urine. In 1923, Phemister repeated the experiments of Neuhof on dogs with essentially the same results. He attributed the ossification to the deposition of calcium salts from the blood and lymph in the portion of transplant bordering on the lumen where the nutritional conditions are poorest, necrosis is greatest, and the acidity of the tissue is increased by the acidity of the urine. Phemister extended his observations to rabbits and sheep, which are herbivorous animals with an alkaline urine as opposed to the acid urine of dogs, and failed to obtain ossification of the fascial patches. Axhausen transplanted the gastric and vesical mucosa to the peritoneal cavity in 16 dogs. The transplants were made to the outside of the stomach or urinary bladder and were permitted to stay for from 14 to 70 days. The formation of a cyst, lined by epithelium, occurred, but no bone formation was observed.

DEFICIENCY DISEASE

Clinical Course and Treatment of Sprue D K Miller and W H Barker Arch Int Med, September 1937 60, 385-414

The authors present a review of 33 cases of sprue studied during the past four and a half years. The cases are classified according to symptoms at the time of entrance to the hospital. Severe cases had anemia and diarrhea, moderate cases had diarrhea but no anemia, and mild cases had neither diarrhea nor anemia. All cases gave a history of having had typical sprue symptoms. Recurrent attacks of distention or diarrhea had occurred in all cases over periods varying from one to nine years.

Of these cases 29 were studied roentgenographically. The outstanding findings were (1) a variation in the caliber of the intestinal segments, (2) a distortion of mucosal pattern, usually of the jejunum, but often of the duodenum and ileum, and (3) a segmental distribution of barium probably produced by abnormal motility of portions of the small bowel. The authors emphasize that while these findings were constant in all cases investigated roentgenographically, such manifestations cannot be regarded as pathognomonic of sprue. They are probably due to improper fat absorption in the small intestine.

Treatment resulted usually in marked amelioration of symptoms. The treatment consisted of (1) rest in bed, (2) high protein, low fat, low carbohydrate diet, (3) parenteral liver extract.

H A JARRE M D

DIATHERMY

Measurements on Biological Phantoms with Very Short Waves of Great Energy J Pätzold Strahlen therapie, 1937 60 700

The author studied the effect of various wave lengths on fat and muscle. For the 6 meter wave the temperature ratio was 16:1 and for a 1 meter wave 3:1. This would indicate that the 1 meter wave is preferable especially for heating the pelvis because the difference in the heating of fat and muscle is much less than for longer waves.

ERNST A POHLE M D Ph D

DIPHTHERIA CARRIERS

The Use of Roentgen Rays in Diphtheria Carriers W Streil Strahlentherapie 1938 61, 130

The author used roentgen therapy in 150 cases of diphtheria carriers. Technic 150 kv 4 ma, 0.25 mm Cu + 10 mm Al 6-8 fields over the nasal area and over both tonsils 50 r per field. The first smear was taken two or three days after the exposure and then from four to six days later. If the second smear was reported positive the second and sometimes the third exposure was given. The patient was discharged after three negative smears had been reported. The

treatment was successful in 95 per cent of the patients who excreted bacilli and in 97 per cent of those who were carriers. Because of the good results obtained and the economical advantages, roentgen therapy of diphtheria carriers is recommended by the author.

ERNST A POHLE M D, Ph D

Radiotherapy in Diphtheria Carriers Laquerrière, Kuentz, and Roget Bull et mém Soc de Radiol med de France October, 1937, 25, 681, 682

The authors describe their experience in the treatment of 17 cases of diphtheria carriers with success in curing every case. Technic 100 r with 5 mm Al filtration at 125 kv. They gave one treatment every three or four days. From two to four treatments usually were sufficient. They believe the method should be used in every case in which the usual methods of treatment do not clear up the nasopharynx of the diphtheria carrier.

S R BATTY M D

DOSAGE

The Determination of the Dose in Radium Therapy of Carcinoma of the Cervix J J Hirsch, Strahlentherapie, 1938, 61, 48

The author undertook a comparative study of the methods of radiation therapy for carcinoma of the cervix as practised at the Curie Institute in Paris and the Radiumhemmet in Stockholm. At the present time there is no direct relationship between the amount of radium applied and the tissue dose. He believes that this can be established as soon as radium doses can be expressed in international r. The photographic method developed by Holthusen and his school seems to be a suitable method to reach this goal. The comparison of the doses in the small pelvis with the Paris and Stockholm methods showed that there is a rapid drop of the intensity toward the parametria. It seems necessary therefore, to supplement the intra-uterine radium application by external irradiation.

ERNST A POHLE M D, Ph D

Dosage Measurements on Ten 400-kilovolt Roentgen ray Generators Otto Glasser Am Jour Roentgenol and Rad Ther November, 1937 38, 769-775

There was found but remarkably slight variation in the quality and quantity output of the same types of 400 kv generators, using General Electric (XPT₁) tubes when tested by the author.

Ten units were examined, six were of the pulsating potential and four of the constant potential. In six installations the tubes were suspended in air, and in four they were immersed in oil. The radiation from the oil immersed tubes is somewhat softer than that produced by tubes suspended in air. The highest output in roentgens per minute was produced by a constant potential unit with the tube immersed in oil.

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results in the typical vermiform negative shadows. Variations in the size and shape of the veins, as produced by the phase of the respiration, peristalsis, stripping and mechanical pressure cause a change in the picture. In the early stages owing to pressure by bolus and peristalsis the blood is pressed into abdominal vessels and thus varices cannot be demonstrated and only a slight delay or widening of the lower esophagus from functional failure of the cardia to open is seen. In the terminal stages also, stasis is noted.

The method of examination is the oblique recumbent position at the end of full inspiration (veins filled), and five seconds after swallowing a very small amount of a thick barium preparation that will demonstrate mucosal folds. Air bubbles can be excluded by films in various positions. Fluoroscopy is not very helpful.

S. M. ATKINS, M.D.

Pharyngo-esophageal Diverticulum. Analysis of 53 Consecutive Operative Cases. F. H. Lahey and W. B. Hoover. *New Eng Jour Med* April 8 1937, 216, 591-597. (Reprinted by permission from *British Med Jour* Aug 7 1937, page 23 of *Epitome of Current Med Cal Literature*.)

The authors analyze 53 consecutive cases of operation for diverticula of the lower pharynx and upper esophagus. Of these cases, 43 were men and ten women. The outstanding symptoms of this condition are difficulty in swallowing, regurgitation, gurgling noises, choking attacks and loss of weight. The diagnosis can usually be made from the clinical history but should be confirmed by a careful roentgenologic study. The x-ray examination also rules out other lesions of the esophagus and ascertains the size, shape, and position of the sac. The operation for such diverticula is done in two stages. At the first operation the sac in the neck is completely freed, the encircling constrictors are carefully dissected and cut, and the dome of the diverticulum is then fixed high in the wound so that it lies at a higher level than the opening into the esophagus. This operation relieves the patient's symptoms at once. The second one takes place from eight to 12 days later and the sac is then amputated. The authors recommend a special dissection of the mucosa from the submucosa: a small cuff of mucosa is pushed into the neck of the sac and the submucosa sewn over it, and in this way leakage can practically always be avoided. Most of the patients require post-operative dilatation and this must often be continued for a year. In the authors' series good results were obtained in 49 cases, poor results in two cases and two were failures.

Cardiospasm. E. K. Frey and L. Duschl. *München med Wchnschr*, Aug 27 1937, 55, 1374-1377.

There is considerable discussion as to the true nature of this condition and this is exemplified in the various terms employed in describing this entity, thus 'hiatus spasm' is definitely a misnomer as is the term 'cardio-

spasm'. 'Dysphagia paradoxa' reveals nothing as to the etiology of the condition. 'Achalasia' or absence of relaxation, has much in its favor, though all observers are not in accord with this explanation of the *modus operandi*. 'Idiopathic dilatation of the esophagus' or other similar names only attest to our ignorance of the subject and probably should never be used. Starck is quoted as considering the entity as one of cardiotomic dilatation of the esophagus. Roentgenologically, the condition is observed to vary from mere cylindrical dilatation to actual mega esophagus. It is very possible to have a pathologic narrowing of the esophagus without proximal dilatation.

In what is commonly considered a typical case at the site of narrowing the pathognomonic conical tapering is observed toward the cardia. The swallowing function, filling and emptying of the esophagus, are essential in diagnosing early cases and it is imperative to obtain roentgenograms in both oblique projections. A rather detailed account of all the varied theories offered to explain this entity are briefly and well presented. In summary, these are possible: congenital basis, absence of relaxation reflex, true spasm, inability of efficient contraction of longitudinal esophageal musculature, primary atony after infectious diseases or trauma, disharmony of autonomic and sympathetic nervous systems and psychic trauma. These theories explain the efficacy of such divergent therapeutic procedures as auto-suggestion and hypnosis, atropine and other antispasmodics, dilatation, sympathectomy, esophageolysis, cardiomyotomy, cardioplasty and esophago-gastrotomy.

W. R. STECHER, M.D.

Notes on the Roentgen Picture of the So-called Esophagus Lip. Gunnar Jonsson. *Acta Radiologica* May 1937, 18, 452-459.

The author points out that in making a roentgen examination of the hypopharynx and the upper part of the esophagus there is now and then observed a rounded bulging in the posterior wall immediately below the cricoid cartilage. This bulging has been said to depend on a swelling of the mucous membrane caused by a foreign body. The author however has noted that normally one not infrequently observes a bulging on the border between the hypopharynx and the esophagus that this bulging corresponds to the so-called esophageal lip demonstrated by Killian and that it probably results from the lower part of the musculus cricopharyngeus which acts as a sphincter muscle in the esophageal mouth. The part played by the mucous membrane in this bulging requires further investigation.

W. A. SODEMAN, M.D.

Traction Diverticulum of the Esophagus. Roentgenographic Demonstration. Symptoms Noted in Series of 26 Patients. R. P. Wallace. *Arch Int Med* September 1937, 60, 454-457.

Although traction diverticula are usually considered

in the following renal diseases, *viz* lithiasis, tumors, infarct, hydronephrosis, and pyonephrosis. The majority of recent textbooks and monographs on urology and pathology fail to mention its occurrence. In the older textbooks by Rayer, Roberts, and Dickinson, ossification of the human kidney is mentioned as a rare finding, but from histological studies it is evident that many of these so-called cases of ossification are, in reality, cases of calcification. For example, Rayer described a type of ossification of the kidney called "osteoides," which possessed a fibrous structure, was traversed by blood vessels, contained calcium deposits, and was separated from the renal tissue by a membrane. He considered "osteoides" to be analogous to the fibrous bodies in the uterus and noted their occurrence in "acephalocysts" (hydatid). From this description it would appear that "osteoides" have been confused with calcification of the walls of a hydatid cyst.

(A) *Hydronephrosis or Pyonephrosis*—The earliest case of ossification of the kidney, according to Rayer, is the case published by Vincent in 1889, in which the kidney weighed one and a half pounds and was of cartilaginous consistency. Rayer also cited a case reported by Fearon of a female, 50 years of age, who had died after an anuria of six days' duration. Post-mortem examination failed to disclose a kidney on the affected side, but in its place was found an ossified substance. Rayer also reported a personal case occurring in a female, 50 years of age, who had a tumor in the left hypochondriac region; at post-mortem examination, the left kidney was found to contain a calculus in the mid-portion and in the lower pole there was a cartilaginous formation with osseous foci.

Roberts commented upon the fact that sometimes the fibrous septa which separate the pus pockets in a pyonephrotic kidney become extensively calcified and occasionally ossified. He cited an unusual specimen which was sent to him for examination by Dr. John Mudd, of Manchester. A saw was required to cut across the kidney. A piece of one of the bony septa, which was

ground down and examined under a microscope, showed the characteristics of true bone, though in a rudimentary state. He also cited a specimen of similar osseous transformation of the kidney preserved in the museum of the Manchester Infirmary. Dickinson also commented upon the rarity of true bone formation in the kidney and mentioned its occurrence in association with cysts, pyonephrosis, and pyelitis.

Stoppato (1923) reported a case of partial hydronephrosis due to renal calculi with heteroplastic ossification of the walls of the hydronephrotic area in a 22-year-old male. Two calculi were found, the larger one was free but the smaller one was attached by osseous tissue to the walls of the localized hydronephrosis, the size of an orange in the upper pole of the kidney. A similar case was reported by Lozzi in 1923. It is extremely difficult to determine whether the osseous process in the walls of the hydronephrosis in these two cases is primary, *i.e.*, the result of metaplastic changes in the affected tissues or secondary to osseous changes associated with renal calculi, as described by Phemister, Hellstrom, and Stuart and Kirkorian. The authors are inclined to favor the latter view.

(B) *Renal Calculi*—Osseous metaplasia of the renal pelvic epithelium associated with renal calculi is a rare pathological phenomenon. Phemister (1923) reported two such cases in which there were three stones, composed partly of living bone and attached to the renal pelvis in two cases and to a pyramid in one. The bone formation was of the spongy variety and contained marrow, fat, loose fibrous tissue, and capillaries in cancellous bone tissue. Similar cases were subsequently reported by Hellstrom (1931), Lozzi (1931), Stuart and Kirkorian (1932), and Huggins (1933).

The pathogenesis of the osseous metaplasia in these cases may be attributed to irritating and erosive action of the rough irregular stones upon the pelvic epithelium which is followed by an osseous metamorphosis in the connective tissue beneath the pelvic mucosa. The osseous metaplastic

characteristics The anterior portion, lacking muscle, is ballooned out to a cylindric canal Some resistance is encountered in injecting the muscle-containing membranous urethra Spasm of the muscle may lead to emptying of this portion if the film is taken after the injection The anterior urethra has sharp borders These are parallel in the penile portion but show enlargement into the bulbar dilatation below the symphysis The posterior urethra is a narrow band showing an oval swelling at the prostate, in the center of which is a clear spot The bladder neck appears as an estuary preceding the prostatic urethra Some variation in appearance with age occurs

Urethral strictures give a characteristic sharp narrowing of a normally dilated portion of the canal, they are to be distinguished from spasm by the fact that the latter is most frequent in the region of the membranous sphincter Crypts and diverticula are well demonstrated, and always pathological Demonstration of the glands of Littre and Cooper and the crypts of Morgagni never normally occurs Prostatic crypts may be shown A globular dilatation of the prostatic sinus is generally due to an old gonorrhea Disappearance of the "spot" of the verumontanum indicates prostatic hypertrophy as do displacements of the canal The most characteristic sign of this condition however, is saber-blade deformity of the urethra (Chevassu's sign) Deformity of the bladder may also be shown

Trauma may lead to complete severance of the urethra, marked by a sudden end of the injected medium to stricture or to angulations without stricture.

Gonorrhea may lead to stricture peri-urethral abscess, fistula or changes in the prostate. In stricture, radiography is of great value in demonstrating the exact extent of the lesion, which cannot be shown in any other way It is also a helpful check on treatment Abscesses and fistulae are best delineated by urethrography Prostatic abscess in the early stage causes displacement of the urethra while, after spontaneous evacuation, a fistula is formed Chronic prostatitis may lead to abscess cavities in this gland single or multiple The x ray signs of diffuse prostatitis are indefinite but the distinction from cancer is important The presence of multiple cavities with or without stones is a differential point In old prostatitis obliteration of the verumontanum may occur

Tuberculosis leads to very destructive lesions especially in the prostate, often with reduced bladder capacity

Prostatic hypertrophy leads to deformity of the canal lengthening change of direction flattening of the transverse diameter, and deformity of the bladder neck The verumontanum is always effaced The saber blade deformity is shown on oblique views The normal muscular activity of the posterior urethra is lost In cases without clinical enlargement the urethrogram may show changes to be present.

Cancer of the prostate produces variable signs deformity infiltration or edema of the walls or elevation of the bladder floor

Post-operative studies show that cystotomy has no effect on the urethral obstruction due to prostatic enlargement Study after prostatectomy shows that the bladder neck is reformed by the fourteenth day A triangular dilated midsegment of the urethra occupies the site of the excised gland

The article is a beautifully illustrated and careful review, well worth reading

LEWIS G. JACOBS, M D

Gravel in the Kidney and Ureter G Marion Jour Urol, April 1937 43, 297-303 (Reprinted by permission from British Med Jour, Aug 14, 1937, page 25 of Epitome of Current Medical Literature.)

Marion records five cases in which gravel in the kidney or ureter caused partial or complete obstruction It is suggested that post-operative anuria may sometimes be due to obstruction of the renal tubules by crystals which are formed after certain operations on the urinary tract The formation of gravel in the ureter is usually followed by its spontaneous passage, and this may be unnoticed if the patient possesses both kidneys, but when one has previously been removed anuria may be produced, and two instances of this are described Gravel in the pelvis of the kidney gives rise to the same symptoms as calculus, and in some cases the gravel fills the whole of the pelvis and calices Sometimes it is passed as a result of medical treatment, an instance is given of a young girl in whom radiography showed a stone the size of a bean, while an earlier film had shown it to be coral-shaped and much larger It was established that, in the first x ray plate, what appeared to be a large branching calculus was really gravel which had passed in the interval between the taking of the two films Pyelotomy was later carried out for the removal of the stone Any variety of lithiasis may give rise to this gravel formation, and in three cases in which the deposit was analyzed it was found to consist of oxalates urates, and phosphates A correct diagnosis cannot always be made by radiography but when anuria is present and no stone can be seen gravel should be suspected In this case, as when a stone is present, the treatment consists of ureteral catheterization, followed by surgical intervention if the gravel or stone is not passed and the obstruction relieved

Calcification of a Bladder Infected with Bilharzia Dilatation of the Uterus and Implantation of Tumor P C Smyrnotis Jour de radiol et d'électrol November, 1937 21, 489-493

The author presents a case of calcified bladder infected with bilharziasis which was diagnosed from the plain films The ureters were thickened and calcified. There was no insufficiency of the ureters and the tonicity of the bladder was normal The author believes that the bladder does not always hypertrophy or calcify in this condition neither is cancer formation more fre-

changes are not due to metaplasia of the connective tissue of the kidney parenchyma adjacent to or invaded by the tumor

Information concerning the roentgenographic findings in these cases is not available excepting in the cases reported by Arkin and Moro. The latter case showed a calcified shadow about the size of a goose egg which was interpreted as a calcified cyst. In the absence of roentgenographic details in the remaining cases, it is difficult to predict the type of shadow by the osseous tissues within the tumor, but obviously the intensity of shadow varies according to the degree of osseous metaplasia and the size of the tumor.

3 Mixed Tumors—Bone formation in the human kidney is more commonly associated with mixed tumors (embryoma or teratoma) than with any other type of renal lesion. These mixed tumors are not strictly limited to infants and children but may occur in adults.

Hedren (1907) reported the first case of extensive bone formation in a mixed tumor in a female 54 years old. Lomon (1913) reported a case of osteoma of the kidney (confirmed by operation) in which a diagnosis of kidney tumor was made from the roentgenographic findings, *i.e.*, enlarged kidney outline, situated low, and spotted with small dense shadows. Thiede (1913) described a case of osteochondro-fibroma of the kidney capsule. Pirondini (1917) described a case of osteoblastoma in a 37-year-old male. Hildebrand observed a fibro-myo-osteosarcoma, weighing two kilograms, in a female 30 years old. Desnos (1923) reported two cases of osteofibroma of the kidney in males 48 and 35 years old, respectively, and cited similar cases by Marion and Brugnatelli. Ssoroka (1931) observed mixed tumors in two adults, 38 and 58 years, respectively, in one of which osseous tissue was noted. Hamung and Poole (1936) described a case of osteoblastoma of the left kidney, with osseous metastasis to the other kidney, and in a male 76 years old.

(D) Vascular Lesions of the Kidney 1 Endothelioma—This type of ossification is

extremely rare, as only two cases could be found in the literature. Ponzio (1913) reported an unusual case in which an ovoid shadow about the size of a hazel nut was found on the renal region in the plain roentgenogram, and diagnosed as a renal calculus. At operation, no trace of a calculus was found but, following nephrectomy, a firm, smooth, ovoid body, the size of a nut, was found in the renal bed and was extirpated. It was made up of calcareous and bony portions and contained a soft bloody coagulum. Histological examination of the wall of the osseous formation disclosed the characteristic structure of a vein, with preservation of the endothelium, muscular coat, and adventitia. The author considered the growth to be an endothelioma but was unable to state whether the vein belonged to the renal cavity proper or to some retroperitoneal tissue.

2 Infarct—Schmorl (1930) reported an unusual case of ossification of the kidney, associated with complete interference with blood supply to the kidney. The patient had developed a complete infarction of the blood supply of the kidney, with subsequent formation of bone beneath the mucosa of the renal pelvis. This type of calcification is analogous to that obtained by Sacerdotti and Frattin following permanent ligation of the renal pedicle; this case is the only one of its kind found in the literature.

CONCLUSIONS

A review of the literature and a study of personal cases of calcification of the kidney, associated with various renal diseases, warrant the following conclusions:

1 Calcification of the kidney is an infrequent, though not uncommon, pathological finding.

2 Calcification of the kidney may occur in two forms: (a) metastatic and (b) non-metastatic. The non-metastatic group may be further subdivided into the two following types: (a) calcification associated with acute or chronic inflammatory diseases of the kidney—*kalkgicht*, (b) dys-

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CALCIFICATION AND OSSIFICATION OF THE KIDNEY

A REVIEW OF THE LITERATURE AND A REPORT OF CASES

By A E GOLDSTEIN, M D, and B S ABESHOUSE, M D, Baltimore, Maryland

From the Urological Service, Sinai Hospital, Baltimore

PART II²

(D) *Vascular Diseases of the Kidney*

1 *Arterial Calcification*—Arterial calcification has attracted much attention in recent years. This phenomenon is observed in the two main types of arteriosclerosis. In the atherosclerosis type, calcification appears to be limited to the intima, whereas in the medial calcification—so-called Monckeberg's disease—these changes are observed chiefly in the media. In both types, calcification has been produced experimentally by adding acid or alkali to a high calcium diet (Rabl), by administration of parathormone (Huepner) and by injection of irradiated ergosterol (Kreitmar and Moll). Isolated or disseminated calcification of the arterial system may occur in the various bone diseases (Barr and Charles) and may be unaccompanied by calcium deposits in other organs. On the other hand, this type of calcification has been reported in combination with metastatic calcification of the kidney, lungs, and stomach by Schultze in a case of osteosclerosis and by Schmidt in severe nephritis.

The most familiar example of arterial calcification in the kidney is the calcified pipestem renal arteries associated with

generalized arteriosclerosis. These calcified arteries are seldom visualized in the plain roentgenogram, probably due to the fact that the amount of calcium salts deposited in the arterial walls is insufficient to cast a shadow through the overlying tissues. The authors have had the opportunity of examining the roentgenograms in 15 cases of extensive calcification of the abdominal aorta reported by Feldman and one case of calcification of an aneurysm of the abdominal aorta, and in none of these cases was there any roentgenographic evidence of calcification of the renal arteries. The calcifying process not only involves the main renal arteries but also the large intrarenal branches of these arteries. In 1931, Fish and Hallock reported a case of calcification of the intrarenal arteries so extensive as to give the roentgenologic appearance of calculi or tuberculosis. The correct diagnosis in their case was established at autopsy when, in addition to sclerosis and calcification of the renal arteries and their branches, calcification of the aorta and carcinoma of the lung with metastases were found. Recently Tilier reported aortic calcification simulating calculi of the ureters in a case of renal lithiasis.

Calcification may also occur in the renal veins, as indicated by the report of Sterling

² See classification, Part I, page 549

THE ROENTGEN TREATMENT OF CHRONIC SINUSITIS¹

By FRANK E BUTLER, M D , and IVAN M WOOLLEY, M D , *Portland, Oregon*

From the Department of Radiology, University of Oregon Medical School

IN the long history of infection of the nasal accessory sinuses, the final chapter has not yet been written. Although it is one of the oldest of medical problems, little was accomplished in the way of treatment prior to fifty years ago. To our predecessors it presented a baffling problem and little was done beyond diagnosing the condition as catarrh and abandoning the victim to be preyed upon by the patent medicine vendor. With the development of rhinology the challenge became more sincerely accepted and during the past thirty or forty years much constructive work has been accomplished. In more recent years a vast amount of careful scientific study has been carried out which has resulted in a more accurate understanding of the varied underlying causes and the treatment.

Well trained observers have probed deeply into the anatomy, physiology, histology, and pathology of sinus disease, and skilled surgeons have devised technical procedures for the relief of its sufferers. Despite all of these efforts there still remain too many sufferers who fail to respond to any or all of the available methods of treatment. That the problem is a complex one is recognized by all who have occasion to treat this disease. Factors underlying its pathology are many and varied, and because of this fact the treatment also must be varied according to the cause. It is not the purpose of this paper to discuss all of the methods employed; it is sufficient for this discussion to direct our attention to those patients suffering from chronic infection of the nasal accessory sinuses who have failed to gain relief from other conservative methods of treatment and who, therefore, face the possibility of so-called radical surgery. We

do not disapprove of radical surgery when performed upon patients who have exhausted the more conservative procedures without relief, providing the surgeon who performs the task is well skilled in this technically difficult operation. Unfortunately this has not always been the case, and the failures have been so widely advertised that the patients and their physicians have become rather reluctant to face the ordeal. The pendulum has now swung back to a more conservative position and a renewed effort to find less formidable methods has been the result.

During the past seven years we have observed the effects of the roentgen ray as a therapeutic agent in chronic sinus disease, and during this time we have studied the results on experimental animals as well as the clinical observation of well over two thousand treatments. With this experience as a basis, we believe that we are justified in pleading for a more general use of this valuable aid in those cases adapted to it.

That the roentgen ray is an agency that should be expected to be effective has been proved in other fields. Dunham (1), Desjardins (2), Kelly (3), Hodges (4), and many others in America and abroad have published works supporting this statement. In 1923, Osmond (5), of Cleveland, reported a series of cases of acute sinusitis treated by roentgen ray with good results.

The mucosa of the sinuses is thinner and much less vascular than that of the nose and, therefore, is less resistant to infection. It is provided with numerous cilia which serve to waft toward the ostium a web of mucin which is constantly being secreted by the many goblet cells. During the course of an infection there is an engorgement of the mucosa due to increased blood and lymph supply. The inroads of infection gradually immobilize the cilia and

¹ Read before the Fifth International Congress of Radiology, Chicago Sept 13-17 1937

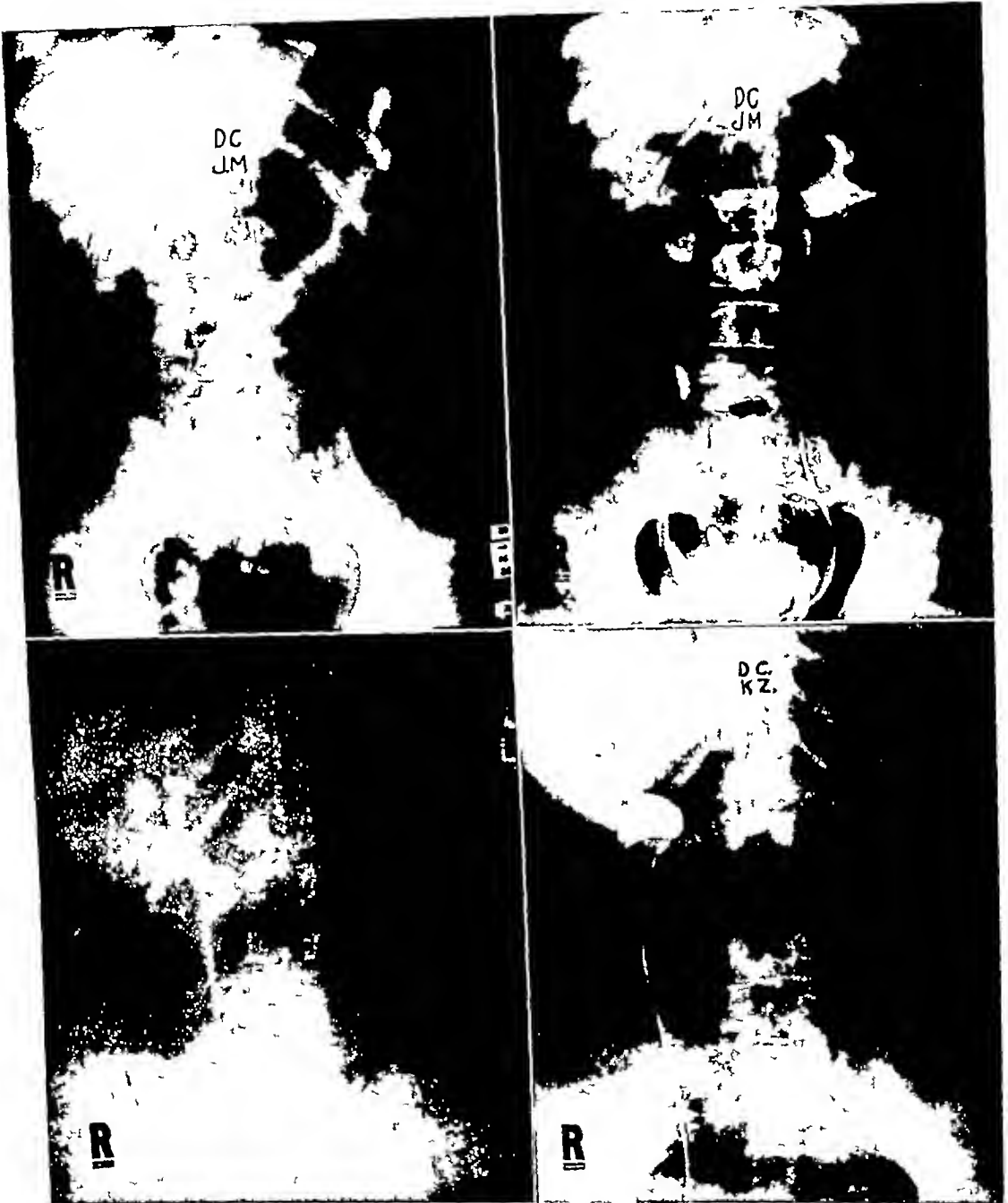


Fig 18 (upper left) Case XVIII Plain roentgenogram showing several irregular areas of calcification in the region of the right kidney following an injury to the kidney one year previously

Fig 19 (upper right) Case XVIII A bilateral pyelogram showing a moderate hydronephrosis (left) The dye was irregularly dispersed in the right kidney and partly obscured the calcified shadows noted on the plain film The operative specimen disclosed an acute and chronic pyelonephritis with an old laceration in the upper pole of the kidney Many old organized blood clots containing calcium deposits were found in the pelvis

Fig 20 (lower left) Case XX A pre-operative pyelogram of right kidney with arrow pointing to a calcified shadow which was present in the cortical area and did not appear to be connected with the upper calyx or pelvis This same shadow was present in the plain film A diagnosis of cortical stone was made and confirmed upon operation The large calcified shadow seen in the left kidney region proved to be a calculus in the pelvis of the lower and larger half of a double kidney

Fig 21 (lower right) Case XX A post-operative pyelogram taken after removal of the cortical stone in the right kidney

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19 of which were removed for stone. Huggins observed microlithiasis in two patients who presented osseous metaplasia associated with calculous disease. Huggins found microliths in four of 16 kidneys (of adults) removed for lithiasis. Such high figures lead one to believe that the condition occurs more frequently than is generally believed. Inasmuch as these tubular calculi cannot be detected by our present urological and roentgenological diagnostic measures, it is conceivable that the condition frequently passes unrecognized or unsuspected, with the ultimate result that these minute calculi are passed spontaneously or serve as nuclei for the recurrence of calculi.

The pathogenesis of microlithiasis has not been clearly established. The condition has been observed not infrequently in many cases of experimental renal lithiasis. It has been found after intravenous injections of uric acid and some of its constituents by Heidenhain, Ebstein and Nicolaier, and Minkowski, after parenteral administration of oxamide and intravenous injection of ovalates by Ebstein and Nicolaier, Keyser, and Huggins, and in vitamin A deficiency by Van Leersum. The various theories which have been proposed to explain the occurrence of larger renal calculi are also offered as an explanation of microlithiasis, but clinical and pathological substantiation of these hypotheses is still lacking.

Unfortunately, bacteriological studies in these cases have not been made except by Crabtree, who found a *B. coli* infection in three cases. It is extremely difficult to draw any conclusions from these meager findings but undoubtedly infection occasionally does play a rôle in the development of microlithiasis.

Faulty urinary drainage resulting from obstruction and stasis has been emphasized by Braasch and Crabtree as a possible factor in the development of microlithiasis. Braasch maintains that dilatation of the tubules resulting from faulty drainage is a necessary prerequisite of microlithiasis. Crabtree found some form

of obstruction in each of his three cases. The obstruction may be due to an aberrant vessel of the ureteropelvic junction on occlusion of a calyx by a stone or stricture, or a localized lesion of the papillæ such as a papillitis or fibrosis. In 1913, Caulk reported a case of obstructive calcareous papillitis which resulted in the formation of a non-calcified cyst, the size of a walnut, limited to the affected pyramid. He attributed the obstructive calcareous papillitis to either a primary calcium infarct with gradual deposition of salts and secondary sclerosis or to a primary necrosis with sclerosis and secondary calcification. On the other hand, Huggins maintained that microliths are not found where there has been much necrosis of the papillæ from the pressure of a hydronephrosis or infection.

In this connection, it is interesting to note that Randall has recently stressed the rôle of minute papillary and calyceal lesions in the formation of renal calculi. He pointed out that the initiating lesion is usually found either at the tips of the papillæ, within or around the tubules, or in the calyceal mucosa about the pyramids, and this lesion serves as a focal point for the precipitation of crystalloids or colloids (usually calcium phosphate or ovalate). At first the deposits of calcium phosphate or ovalate are usually subsurface, being intratubular or extratubular, but later the plaque becomes denuded of its overlying epithelium and serves as a nucleus for further deposition of salts.

On gross inspection of kidney surface in cases of microlithiasis, no unusual changes are observed. On cross-section, a gritty sensation may be imparted to the knife and inspection of the cut surface may reveal minute white (calcium) deposits confined to the tips of the papillæ, but occasionally pyramids stand out clearly because of the punctate or linear deposits in them. In many instances, the microliths are not recognized unless serial sections of the pyramids are made.

These minute calculi are usually found within the lumen of the straight collecting tubules and occasionally in the convoluted

irradiation We have had several such cases wherein the symptoms subsided and the membranes underwent resolution, leaving the cyst unchanged

Our greatest number of failures have been met with in those patients who have failed to gain relief following radical surgery Here we are faced with large masses of scar tissue upon which the roentgen ray cannot be expected to be effective Occasionally, however, we are pleasantly surprised with an excellent result One such case was that of a rhinologist in a nearby city who had himself suffered from sinus trouble for many years He presented himself for treatment with the history of having had a radical surgical attack upon all of his sinuses The efforts had not been successful and he was in constant distress Radiographs revealed a marked fibrosis of all sinuses We explained the probability of failure, but since he had come so far, and knowing that we would do no harm, the treatment was given Fortunately the result was good and he found himself greatly improved Recently he has published a report covering a series of his own cases for whom he recommended roentgen therapy (8)

When the radiographs show an opaque sinus with considerable fibrosis the results have been variable, it would appear that little change can be expected from sinuses in this condition However, some of these patients return free of symptoms, the radiographs showing a normal appearing antrum, others may report clinical improvement of varying degrees, while still others may be outright failures

It not infrequently happens that the patient gains a marked clinical improvement without a complete disappearance of sinus symptoms If the infection has been of a virulent nature with much fibrous repair, the sinuses may not show much, if any, radiographic improvement Many of these patients continue to have post-nasal discharge, but the character of the drainage has changed from one that is laden with pus to one of a clear, thin, gelatinous nature

We have obtained our best results with those patients who have had symptoms of chronic infection extending over a period of months or years, and whose radiographs show a markedly thickened membrane with a small air-containing cavity in the center These patients usually respond to a single treatment Patients in this group usually return in six or eight weeks with clear sinuses, no discharge, and complete absence of secondary symptoms

The effect upon secondary symptoms throughout our series has been interesting and gratifying Headaches, neuritis, bronchitis, and similar manifestations which have been traced to infected sinuses, have in almost every instance cleared up, even though the patient has failed to show a complete resolution of his sinus pathology after irradiation

Throughout this series the reactions have been negligible The average patient will notice an increased nasal discharge, beginning several days after the treatment and persisting for three or four days There may be a mild malaise simulating an acute sinus flare-up Occasionally drainage may be blocked, necessitating antrum washing, although this has been rare in our experience A few patients have developed an early erythema—with in an hour or so—which cleared up within 24 to 36 hours A few patients have developed a true x-ray erythema, but all have cleared up in a short time There has been no case requiring hospitalization or other loss of time In no instance has there been any harmful result A few of our patients, failing to obtain relief from roentgen therapy, have submitted to radical surgery The surgeons have reported to us that they have encountered no difficulty in removing these membranes

The technic of treatment as used in our office for the past seven years is as follows First, the eyes and nose are carefully protected by lead shields For the maxillary sinuses we use a port 1 25 in in diameter The central ray is directed posteriorly, medially, and slightly superiorly, so there

cified changes in the cyst wall. Braasch recently described an interesting case operated upon for infected hydronephrosis in which the kidney contained several cortical cysts. One of the cysts contained a calculus, 1×2 cm in size, and an adjacent cyst contained an organized blood clot. The presence of calculi within a solitary cyst has been reported by Cunningham, Roberts, and Langfeldt. In Cunningham's case, the calculi were found within a calcified cyst.

The cortical stones are usually asymptomatic and may be present for a considerable period of years, until accidentally disclosed during roentgen study for some other coincidental disease. Cortical stones are not always recognized roentgenographically, being most frequently confused with calcification of solitary tuberculous abscess.

Case XX (G U 1,052), K Z, female, 53 years of age, married, housewife, was first examined on Jan 2, 1925. She gave a history of repeated attacks of pain in the right upper quadrant and right lumbar region, radiating to the right shoulder and accompanied by chills and fever.

On Jan 4, 1925, cystoscopic study revealed a calculus in the lower right ureter which was passed following several ureteral dilatations. She subsequently developed left kidney colic in January, 1929. On Nov 12, 1927, cystoscopic and pyelographic studies revealed a calculus in the upper pole of the right kidney which appeared to be in the cortical zone (Fig 20). A large coral calculus was found in the lower—and larger—half of a double kidney on the left side. Both kidneys were severely infected and showed a marked reduction in function. On Dec 20, 1927, a right nephrolithotomy was performed. The calculus was found completely encysted in the cortical area adjacent to the upper major calyx. There was about 2 mm of tissue separating the stone from the kidney capsule. The stone was round and measured 2.5×1.4 cm. No communication was found between the cystic cavity and the upper major calyx.

On June 22, 1933, she developed signs and symptoms of a left perinephritic abscess secondary to calculous pyonephrosis of the lower half of the double kidney. Immediate operation was advised, but refused. At operation ten days later, a large collection of thick green pus (about three quarts) was found around the left kidney, and drainage was instituted. The patient died on the third post-operative day, of sepsis. At autopsy, the chief findings were confined to the left double kidney, the upper rudimentary segment of which appeared to be normal while the lower segment was a massive multilocular pyonephrosis and contained a large branched calculus that had ulcerated through the posterior wall of the pelvis.

3 Putty-like Formations—In 1930, Braasch called attention to three unusual types of urinary calculi which are occasionally present in the kidney, and which he considered to be not true calculi but semicalcified bodies, *viz*: (1) putty-like bodies, (2) masses of sandy material, and (3) semiorganized blood clots with calcareous deposits.

These soft masses are composed of necrotic tissue, desquamated epithelial cells, a few red or white blood cells, and a small amount of mineral salts. Their shape conforms to the cavity in which they are found. They are usually multiple, and are most frequently found in the terminal calices, where they appear as grayish-black or dark brown oval or spherical masses varying in size from that of a pea to that of a marble. Occasionally, they may form a complete cast of the pelvis or ureter. They are usually associated with chronic infectious process in the kidney, such as a pyonephrosis or chronic suppurative pyelonephritis. The authors have frequently encountered these putty-like bodies in simple pyonephrotic and calculous pyonephrotic kidneys, their presence being unsuspected prior to operation despite careful roentgenographic studies.

The shadow-casting properties of these

OLOGY

(5) OSMOND, JOHN D. Roentgen Therapy of Acute Infections of Antrum and Frontal Sinus. *Am. Jour. Roentgenol. and Rad. Ther.*, May, 1923, 10, 374-377

(6) BUTLER, FRANK E. and WOOLLEY, IVAN M. Roentgen Therapy in Chronic Sinusitis. A Further Report. *RADIOLOGY*, November, 1934 23, 528-535

(7) FENTON, RALPH A., and LARSELL, OLAF. Histocytes in Acute and Chronic Inflammations of the Accessory Sinuses. *Trans. Am. Acad. of Ophthalmol. and Otolaryngol.*, 1932

(8) WARREN, E. D. The Value of X ray Therapy in Chronic Sinusitis. *Laryngoscope*, November, 1935, 45, 864-876

retention products On July 27, 1936, the blood calcium was found to be 12.5 mgm and the blood phosphorus 3.7 mgm On admission, the phthalein test showed a 3 per cent excretion for the first hour and a similar amount for the second hour

On July 16, 1936, cystoscopy and pyelography were performed The plain roentgenogram showed an enormous enlargement of the right kidney which contained several huge stones and myriads of small pinhead calcified shadows surrounding the larger stones (Fig 22) In the right ureter below the lower end of the right sacro-iliac joint, there was a large oval shadow which appeared to be a conglomeration of numerous smaller shadows There were several large stones in the left kidney area (Fig 22) The following pre-operative diagnosis was made (1) nephrolithiasis, bilateral, (2) right ureteral calculus, (3) calculous pyonephrosis, non-functioning

On July 27, 1936, a right nephrolithotomy was performed The large stones and a large quantity of pus were evacuated In the lower portion of the kidney there was about a pint of sand and gravel which had the appearance of caviar The patient died about two hours after the operation

A partial autopsy was obtained and performed shortly after death The right kidney contained several large calculi and showed extensive pyonephrotic changes A very large amount of small black calcareous concretions, resembling small shot in appearance, was found lying in the pelvis and upper pole of the kidney, a larger stone measuring 3 cm in length was found and trapped at the terminal calyx Throughout the kidney there were numerous abscesses containing thick greenish pus The left kidney also contained several large calculi and presented a moderate degree of pyonephrosis

IV CALCIFICATION OF THE KIDNEY ASSOCIATED WITH GASTRO-INTESTINAL DISEASES (TYPE II)

(A) *Pyloric Obstruction*—The interrelationship between pyloric obstruction and

calcification of the renal epithelium was first noted in 1904, by Nazarro, who found degenerative changes in the renal epithelium and calcareous infiltration in the tubules His findings were made at autopsy in two cases of pyloric obstruction due to chronic gastric ulcer and accompanied by excessive vomiting and tetany Oppenheimer (1923) reported 34 cases of punctate calcium deposits in a series of 347 autopsies and observed calcium deposits in three of seven cases of carcinoma of the stomach and in one case of duodenal ulcer Brown, Eusterman, Hartman, and Rowntree (1923) reported 11 cases of renal insufficiency due to duodenal intonation and complicated by gastric tetany A severe toxic nephritis with granular and lipid degeneration of the tubular epithelium and, with one exception, calcareous deposits in the tubules, was found at autopsy of the six fatal cases Zeman, Friedman, and Mann (1924) found identical changes in four fatal cases of pyloric obstruction, of which two had gastric tetany They considered the renal condition to be a toxic degenerative nephrosis, and produced similar renal lesions in 11 of 13 cats by ligating the pylorus Cooke (1930) reported similar findings in six cases of pyloric obstruction and vomiting due to gastric ulcer or carcinoma, and attributed the renal changes to the alkalosis Recently Perez-Castro reported similar cases

(B) *Intestinal Lesions*—Calcification of the renal tubules has also been observed in patients with dehydration, alkalosis, and hypochloremia due to diseases of the intestinal tract In 1907, Glaserfeld studied the autopsy findings in 70 children and found calcium infarcts in 30 cases, of which 24 died of gastro-intestinal diseases and six of other diseases, namely, bronchopneumonia, tuberculosis, and sepsis Lightwood (1930) reported six cases of gastro-enteritis and vomiting in infants, who showed calcification of the renal tubules at autopsy Butler, Wilson, and Farber (1936) observed similar changes in a young boy who succumbed to an upper intestinal obstruction and mesenteric

REFERENCES

- (1) DUNHAM, H K Treatment of Carbuncles by the Roentgen Ray Am Jour Roentgenol, 1916, 3, 259, 260
- (2) DESJARDINS, A U Radiotherapy for Inflammatory Conditions Jour Am Med Assn, 1931 96, 401-408
- (3) KELLY J F X ray as Aid in Treatment of Gas Gangrene RADIOLOGY, April, 1933, 20, 296-302
- (4) HODGES, FRED M Roentgen Therapy of Certain Infections Am Jour Roentgenol and Rad Ther, February, 1936 35, 145-155

membrane The calcium deposits are never seen in the form of a layer surrounding the tubules or the blood vessels in the stroma In the early stages, the calcium salts are laid down as small spheroidal or globular deposits and later appear as conglomerate masses These calcium deposits do not cast a shadow on the roentgenogram nor are they discernible to the naked eye on microscopic examination Histologically, it is relatively simple to distinguish this type of calcification from that occurring in bichloride of mercury and other metallic poisoning In the latter type, the calcium deposits appear as formless masses or casts in the lumen of tubules or in the necrotic tubular epithelium

(F) *Dietary Deficiencies and Faulty Nutrition*—There is much clinical and experimental evidence to establish a definite relation between renal calculi and faulty nutrition, particularly an imbalance in vitamins causing defective mineral metabolism However, little evidence has been offered to show a causal relation between renal calcification and dietary deficiencies

In 1924, Rabl was able to produce calcium deposits in the kidneys in mice experimentally by feeding an acid or alkaline or alternating diet The calcification was most marked in the zone between the cortex and the medulla Calcium deposits were also observed in the epithelium and lumen of the tubules, both in the cortex and medulla He attributed the calcification to a renal lesion with decreased phosphorus elimination, and maintained that when the p_H of the blood is raised by giving foods containing an abundance of bases, the excess calcium is deposited in the tissues

Mendel stated that the cells of the renal tubules seem to become calcified in some instances when rats are deprived of vitamin A for long periods De Ruyter recently published photographs of calcification of the tubular epithelium in such cases

Van Leersum observed calcium deposits in the kidney of 88 per cent of the rats fed on a vitamin A deficient diet The calcium deposits were found in the epithe-

lium and lumen of the convoluted Henle's loops and in the straight collecting tubules The author maintained that the calcium deposits passed out of the tubules into the pelvis to act as foreign bodies for the further deposition of inorganic salts Murata observed calcification of the kidney tubules in animals fed on a vitamin C deficient diet Jackson stated that calcium deposits in the kidney may be produced by feeding animals a diet deficient in fat On the other hand, Dixon and Hoyle reported calcium deposits in the kidney, lungs, stomach, and heart of rabbits and guinea pigs fed on a well balanced mineral and vitamin diet to which an extremely large dose of vitamin D in the form of viosterol was added Similar experimental changes were noted by Kreitmar and Moll, Pfannenstiel, and Smith and Elvove Clinical cases of calcium deposits in the kidney due to irradiated ergosterol have been reported by Putschar, Bills and Wireck, and Thatcher

Calcium deposits in the kidney have been observed clinically in relatively few nutritional diseases, aside from those bone diseases caused or accompanied by a deficient nutrition Schmidt pointed out that these calcium deposits are frequently found in the kidneys in gout Walsh and Norton reported three cases of massive renal calculi in association with pellagra and one case with pernicious anemia, but failed to mention the occurrence of calcium deposits in the renal parenchyma in these diseases Turner has shown that since certain pellagrins have some elevation of the blood calcium, one might expect calcium deposits in the kidney Unfortunately, pathological studies of the kidneys in these diseases are not available

V MISCELLANEOUS GROUP (TYPE II)

(A) *Leukemia*—Warthin (1907) reported two cases of leukemia treated by roentgen ray in which deposits of lime salts were found in the kidney On cross-section of the kidney, he found whitish areas and stripes which corresponded to the tubules in the cortical and medullary

innervated by the given trunk (3) The number of nerve trunks, ganglia or plexuses such as are amenable to the resection technic is limited due to anatomical factors as compared with the number of trunks which may be involved in each given case in various types of neuralgias and painful syndromes In such cases the advantage of nerve blocking over surgical resection is most evident, not only because there is no necessity to traumatize large and deep areas of tissues, but also because the modern neurolytic solution is particularly adapted for the temporary destruction of the sensory nerve fibers

The chief difficulties connected with the nerve blocking procedures up to recent times could be divided into three parts (1) Lack of technical means of definitely localizing the area of pain and tracing the nerve fibers, trunks, and plexuses through which painful impulses are being transmitted into the central nervous system (2) Choosing a definite point along the nerve trunk, etc., at which point it is best to interrupt the conductivity and so arrest the passage of painful impulses (3) To block the respectively affected nerves quickly and with a minimum of trauma to the surrounding tissue as well as without necessity and danger of puncturing the nerve trunks with the blocking needles, which condition may occur if the surgeon is depending upon the "mental picture of the underlying skeleton" and his sense of touch

The above, in addition to the fact that we must have exact data as to the precise location and depth of the respective nerve trunk, rendered the nerve blocking a very difficult technical procedure, available only to a few expert specialists who mastered the complicated and artful technic of locating the nerve trunks by means of empirically established landmarks, depending only upon such variegated guides as their own personal tactile sense for the accuracy of the procedure

At the beginning, the injections for "sciatic neuralgias" were made in the gluteal regions, but it was found that the

depositing of rather large quantities of alcohol, its mixtures or derivatives, in the middle of muscular layers which surround the nerve at that level, produces secondary myositis and, in certain cases, constriction sclerosis The painful syndromes which were arrested at the beginning, several months later (after the nerve trunk was fully regenerated from the alcohol fixation) reappeared, due to the new stimuli of painful nature which arose, being initiated by the hardened fibrous sclerotic muscular tissue, which developed following alcohol injection, such reappearing painful syndrome in many instances showed symptoms of even greater severity than the original neuralgia

Means were then sought to limit the amount of anesthetic solution necessary for the interruption of nerve conductivity, and it was found that the only reliable way of doing so was to deposit those small amounts of solutions in close vicinity to the nerve at the point at which the same emerges from the respective spinal foramen, whether it be first or second transverse foramen or lateral vertebral foramen in cervical, dorsal, or lumbar region (Fig 1)

The same was true in other locations when the surgeon was obliged to depend upon relatively large amounts of neurolytic solution and its diffusion for the success of the respective technic On numerous occasions in such instances the unfavorable sequelæ followed the nerve blocking procedure and could be traced to various forms of perineural sclerosis which developed following the destructive action of too strong neurolytic solution which was injected in quantities much too large

Paravertebral or prevertebral nerve block, when performed by fractional technic, is a selective method of precision To perform such nerve block a minimal amount of solution should be employed In order to accomplish this it is necessary for the neuro-surgeon not only to be familiar with the relations that the respective nerve trunks bear to the deep bony landmarks which he is to utilize during the

membrane. The calcium deposits are never seen in the form of a layer surrounding the tubules or the blood vessels in the stroma. In the early stages, the calcium salts are laid down as small spheroidal or globular deposits and later appear as conglomerate masses. These calcium deposits do not cast a shadow on the roentgenogram nor are they discernible to the naked eye on microscopic examination. Histologically, it is relatively simple to distinguish this type of calcification from that occurring in bichloride of mercury and other metallic poisoning. In the latter type, the calcium deposits appear as formless masses or casts in the lumen of tubules or in the necrotic tubular epithelium.

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tient Once this is done the routine therapeutic measures will speedily bring about the long-desired recovery

In the instance just cited a properly administered chemico-surgical neurolysis or nerve block will fully control the pain syndrome The fractional method of paravertebral nerve block neurolysis which can be successfully employed in rehabilitation of various injuries, such as, for example, strains in the lumbar and other regions, secondary post-traumatic neuritis, so-called sciatic neuralgia, various forms of causalgic pain syndromes, and those painful conditions so often associated with peripheral paralysis, depends for its success upon proper localization and visualization

In instances in which it is desirable to resort to such procedures as precision laminectomy or chordotomy, exact knowledge of the location of the respective bony structures which serve as landmarks and beacons to the neurological surgeon is indisputable A great deal of unnecessary surgical traumatism can be eliminated by resorting to x-rays for localization purposes

In carrying out such type of advanced procedure as section of lateral lemniscus at the brain stem, which was promulgated by Dogliotti and which in many instances is the only means at our disposal for relieving the patient of the excruciating and otherwise uncontrollable pain, we must also possess specific knowledge of the localization of various structures involved Undoubtedly this visualization is most important when we are dealing with the treatment and rehabilitation of the industrial worker in whom the syndrome of pain has been the outstanding clinical factor Many such patients are permitted to become chronically disabled, thus becoming a burden to the family and community, notwithstanding the fact that a vast majority of patients of this type can be relieved of their pain and return to their daily occupation if they are only carefully diagnosed neurologically and submitted to the proper form of regional therapeutic anesthesia

We feel certain that when a greater number of physicians recognize the necessity for more precise visualization in connection with various surgical procedures in general, and in connection with neuro-surgery as related to the pain syndrome in particular, then the various methods of surgical relief of pain will become more accurate, more successful, and safer and, therefore, more popularized, thereby sparing the patient months and years of useless pain and agony

The use of x-ray for localization purposes has been aimed at since the introduction of radiography Various methods were devised such as stereoscopy, teleroentgenographic localization, orthodiagraphy, radiographic compass localization, etc, none of these methods being sufficiently simple technically and sufficiently accurate mathematically to be applicable for localization in connection with the surgical treatment of the syndrome of pain

In 1923, George Friedrich Kunz, Jose de Carvajol-Forrero, and Marius B Greene began with research which culminated with the development of x-ray localization technic and measurements to be used for the purpose of localization and identification in crystallography

In 1930, one of us (M B G) developed a new roentgeno-photographic method of localization to be employed in therapeutic nerve block In this way he was able to reduce the time consumed for accurate lumbar therapeutic nerve block from 15 minutes to three His method was only an approximation to actual mathematical precision, furthermore, it did not define depth

In 1932, following independent research by one of us (J K), who has been interested in x-ray localization since the time of the World War (1919), both of us developed a mathematically precise graphic method of x-ray localization Two localization charts were prepared to facilitate the actual surgical procedure of nerve block (1) the Vertical Projection Chart, (2) the Depth Chart

The Vertical Projection Chart defined

negative to the positive phase. In his series of 53 cases, there were only 13 cases below 40 years of age, the youngest patient was 25 years of age. Beer maintained that there was no relation between senile atrophy of the skeleton and calcium deposits. Oppenheimer reported 34 cases of calcium infarcts in 347 autopsies, and found seven cases (20.6 per cent) below 50 years of age and 27 (29.4 per cent) over 50 years. On the other hand, Glaserfeld found 30 cases with calcium infarcts in 70 autopsies on children under two years of age.

From these studies, it would appear that age influences the production of these deposits only insofar as it predisposes to the development of such diseases as cause local changes in the kidney of either a nutritional or toxic nature. The most common disease of old age associated with these deposits is arteriosclerosis. Oppenheimer found arteriosclerosis in 21 of the 34 cases of calcium deposits. It is interesting to note that Glaserfeld found calcification in the peripheral arteries of 42.9 per cent of 70 autopsies in children. It seems likely that renal calcification is frequently encountered in many nutritional diseases to which the aged and feeble are susceptible, but unfortunately detailed observations of these cases are not available.

OSSIFICATION OF THE KIDNEY—OSSEOUS METAPLASIA

Although calcification of the human kidney has been frequently observed in a variety of osseous, renal, and alimentary diseases, ossification of the kidney is a rare pathological finding. At first glance, this appears rather surprising inasmuch as there has been established a very close inter-relationship between calcification and ossification in general and more specifically in the urinary tract.

Heteroplastic bone formation in the urinary tract has been the subject of much experimental study, and those particularly interested in this phase are referred to the excellent and comprehensive articles by Huggins, and by Jones and Roberts. In

the brief review presented by the authors, attention is directed to those experimental studies dealing with ossification and calcification of the kidney.

In 1859, Blessig was the first to demonstrate calcification in the kidney of a rabbit four to six days after ligation of the renal artery. Wells, Holmes, and Henry (1911) showed that calcification of the kidney may develop following a temporary interference of the blood supply of the kidney. They were able to demonstrate calcium deposits in the kidney 36 hours after a temporary anemia (ligation of pedicle) for one hour. The calcification occurred in and around necrotic tubules chiefly in two zones, *viz*, beneath the cortical surface and at the base of the pyramids. Temporary ligation of the renal artery for seven weeks resulted in a heavy deposition of calcium salts such that 25 per cent of the dry weight of the kidney was due to calcium phosphate.

Sacerdotti and Frattin (1901) reported the occurrence of calcification and ossification (formation of bone and bone marrow) in the kidneys of three of four rabbits, 74 to 85 days following permanent ligation of the renal vascular pedicle. The bone was found beneath the mucosa of the pelvis, with spurs extending into the remains of the kidney. In two rabbits the ureter was also ligated, but bone formation was observed in only one rabbit in which a portion of pelvic epithelium persisted. Pocharissky (1905) reported similar results following ligation of the renal pedicle in three of five rabbits. Maximow (1905) reported the occurrence of bone formation as early as five weeks after ligation of the vascular pedicle, and described the process in connection with his work on the histogenesis of blood cells. Liek (1906) observed that bone formation was routinely obtained in the pelvis of the rabbit's kidney within from 16 to 20 days, providing the kidney was wrapped with omentum to secure a free collateral circulation. He found that without this collateral circulation, it required about three months for ossification. He failed to obtain bone formation in four

to the second the lead numeral 2 is strapped along its lower border. This is called Film 2.

IV The Preparation of the λ -ray Table

—Prior to making the necessary λ -ray exposures, the λ -ray table is prepared as follows: (1) The target-film distance is always set at 32 inches, corresponding to one of the two standard factors (Fig 5) employed in the derivation of the "Standard Depth Curves" (target-film distance equals 32 inches). (2) The target is centered over the central longitudinal axis of the table. This position of the target is called "T 1" (Target 1). (3) A plumb line is dropped from T 1 to the table top, denoting the vertical projection of T 1. For abbreviation we will call this point "V T 1" (vertical projection of T 1). A small lead marker is strapped to the table top to correspond to this point. (4) The target is shifted exactly nine inches along the longitudinal axis of the table. This corresponds to the second standard factor (Figs 5 and 7) employed in the derivation of the "standard depth curves" (target-shift equals nine inches). The second position of the target is called "T 2" (see Fig 7). (5) A plumb line is dropped from T 2 to the table top, defining the vertical projection of the T 2. This point is labelled "V T 2". A second lead marker is strapped to the table top corresponding to V T 2.

In our method it is necessary to make two λ -ray exposures, the target always first being put in the T 1 position. Film 1 is always used for this first exposure. When Film 1 is developed the image of V T 1 will be readily identified as the true vertical projection of T 1. The image of V T 2 will be visible also, but will represent a distorted image. This follows from the manner in which the table was prepared (see above). Likewise, when Film 2 is exposed from the T 2 position the image of V T 2 will be identified readily as the true projection of V T 2, whereas the image of V T 1 will now be distorted.

V The X -ray Procedure—The two λ -ray exposures are made in the following manner: (1) The target is placed in the

T 1 position. (2) Film 1 is placed in the Bucky diaphragm. (3) The patient is placed upon the table so that the series of lead markers strapped to the skin points are about five inches lateral to the longitudinal axis of the table. This position is maintained for the two exposures required. (4) An exposure of Film 1 is now made from the T 1 position. (5) The target is moved to the T 2 position. (6) Film 2 is exposed from this position. (7) Both films are processed in the routine manner.

VI The Analysis and Marking of the λ -ray Films

—Each film (see Fig 2 for schematic representation of Film 1) has depicted on it the following: (1) The image of lead numeral No 1 along the upper margin of Film 1. (2) The image of lead numeral No 2 along the lower margin of Film 2. (3) The image of V T 1 (*A* in Fig 2), representing the true vertical projection of T 1 on Film 1, is therefore labelled V T 1 on this film. (4) The image of V T 2 (*B* in Fig 2), representing the true vertical projection of T 2 on Film 2, is therefore so labelled on Film 2. (5) The images of the eight lead markers strapped to each of the tattooed skin points. On Film 1 these are marked by ink spots and designated Sk 1 T 1, Sk 2 T 1, etc. On Film 2 they are similarly marked and designated Sk 1 T 2, Sk 2 T 2, etc. (6) The images of the five designated anatomical structures. On Film 1, they are marked by crosses and designated Tr 1 T 1, Tr 2 T 1, Tr 3 T 1, Sa 1 T 1, Sa 2 T 1. On Film 2 they are marked as before and designated Tr 1 T 2, Tr 2 T 2, etc. (7) On Film 1, V T 2 is marked by making V T 1—V T 2 (see Fig 2) equal to 9 in (the distance of the target shift). (8) On Film 2, V T 1 is marked by making V T 2—V T 1 equal to 9 inches.

VII The Transcription of the X -ray Data—After these points have been marked on the λ -ray films, they are transcribed to a transparent sheet of paper. (1) The points are first transcribed from Film 1 (Fig 3) by superimposing the transparent sheet of paper directly over

Huggins made an intensive study of the relationship of osteogenesis and certain epithelia. He was able to produce bone formation in a fascial transplant to the bladder of a dog, in whom the urine was diverted by transplanting the ureters to the groin, and thus proved conclusively that urine was not a factor in the production of bone in this location. He also obtained true spongy bone around a transplant of either vesical, ureteral, or renal pelvic epithelium to certain parietal fasciæ, *i.e.*, rectus sheath, fascia lata, subcutaneous tissue, and to certain muscle and synovial membranes. Similar transplantation of the cortex or medulla of the kidney or of the prostate did not result in the formation of bone. He also noted that osteogenesis did not occur following transplantation of gall bladder, gastric, jejunal, and colonic mucosa, adrenal cortex, dura mater, or bone shavings into the rectus sheath. The transplantation of epithelium from the urinary tract into the kidney, spleen, and liver also failed to produce bone. He showed that it was the newly formed proliferating urinary epithelium and not the non-proliferating part of the transplant into rectus sheath that was the essential factor in the osteogenetic process, and that another probable factor was the secretion of fluid containing a relatively large amount of calcium and phosphorus into these epithelium-lined cysts resulting from the transplants of urinary tract epithelium into the rectus sheath. Having demonstrated the osteogenetic power of the renal pelvic mucosa, he maintained that this was the probable factor causing bone formation after ligation of renal pedicle in the rabbit.

Several theories have been advanced to explain heterotopic bone formation in the soft tissues. The periosteal theory, which explains the formation of osseous spurs directly connected with bone, is obviously not applicable to bone formation in the kidney. The neoplastic theory offers a plausible explanation of the occurrence of bone in the relatively rare cases of mixed tumors of the kidney which are of meso-

blastic origin and present unusual embryonal and blastomatous features. The metaplastic theory of Leriche and Policard adequately explains most cases of heterotopic ossification of the kidney, particularly these occurring in the human and associated with pre-existing renal lesions. They have pointed out that fibrous tissue, cartilage, and bone are the end-products of a common mesoblastic stem, and that under certain exceptional circumstances any connective tissue may revert to an embryonal state and assume new functions and properties, *i.e.*, fibroblasts may become osteoblasts and form true bone. Confirmation of this theory is found in the heterotopic formation of bone in the experimental animal following the ligation of the renal vascular pedicle and following transplantation of the epithelium of the renal pelvis, ureter, or bladder into the rectus sheath, which has been shown by Huggins to be dependent upon a metaplasia of connective tissue (ossifying fibrocytes) under the influence of newly formed proliferating epithelium. Huggins believed that phosphatase probably played some rôle in heterotopic ossification as in normal bone formation.

It is readily apparent that the same two factors (ossifying fibrocytes and proliferation of epithelium) which explain experimental heteroplastic bone formation, suffice to explain the occurrence of bone in the diseases of human kidney pelvis. Stuart and Kirkorian have maintained that any infective or irritating process in the kidney pelvis, *i.e.*, stones or infection, first causes a proliferation of the renal pelvic epithelium, which, in turn, is followed by osseous metaplastic changes in the connective tissue beneath the pelvic mucosa.

In view of the ready availability of calcium and phosphorus in the urine and the experimental demonstration of unusual osteogenic properties of the epithelium of the renal pelvis, one would expect ossification of the human kidney to be frequently encountered. However, in reviewing the literature, one finds only an occasional report of the occurrence of true osseous tissue



Fig 8 Roentgenogram taken during the process of nerve blocking. The localizing needles are in their respective positions resting against the dorsal surface of the transverse processes. At the lower right angle blocking needle B is found in the exact position below the lower border of the transverse process in the vicinity of the point of exit of the fourth lumbar nerve trunk. 0.25 cc of neurolytic solution must be deposited at this location for a successful therapeutic block. Only through means of x-ray localization can such accuracy of technique be secured.

the horizontal axis $V T 1-X$, the depth of the transverse process above the plane of the plate, $D Tr 3$, may be read along the vertical axis $V T 1-T 1$.

IX The Vertical Projection Chart—Since all points are charted (Fig 4) in a like manner, we will demonstrate only the plotting of the vertical projection of $Tr 3$ (1) Line $V T 1-Tr 3 T 1$ is drawn, (2) Line $V T 2-Tr 3 T 2$ is drawn (3) These lines intersect at $V Tr 3$, the vertical projection of $Tr 3$.

All other points are localized in the same way, so that when this has been done the vertical projection of all the points is demonstrated. This constitutes the vertical projection chart (Fig 6-A).

X The Depth Chart—After the vertical projection chart has been prepared,

these points are transcribed to a second sheet of paper (Fig 6). A line $A-B$ is drawn parallel to the axis of the localized skin points, that is, parallel to $V S K 1-V S K 2-V S K 3dc$.

Since all the points which go to make the depth chart are plotted in the same manner we will demonstrate only how the depth $D Tr 3$ is plotted (Fig 6). (1) Point $V Tr 3$ is projected upon line $A-B$. Its projection is called "C". (2) Line $V Tr 3-C$ is extended to "E". (3) The image shift, $S Tr 3$ is obtained from the transparent sheet upon which the x-ray data have been transcribed (Fig 4). (4) Image shift $S Tr 3$ is applied to the "standard depth curve" along its horizontal axis $V T 1-X$ (Fig 5). (5) The depth $D Tr 3$ is obtained along the vertical axis $V T 1-T 1$ (Fig 5). (6) Depth $D Tr 3$ is now applied along line $C-E$ (Fig 6-B) so that $C-H Tr 3$ is equal to $D Tr 3$. (7) $C-H Tr 3$ ($D Tr 3$) represents the depth (used synonymously with *height*) of the third lumbar transverse process above the plane of the plate. In the same way the depth of the other anatomical structures ($H Tr 1$, $H Tr 2$, $H Sa 1$, $H Sa 2$) are plotted, as are also the depth of the skin points ($H Sk 1$, $H Sk 2$, etc.). The skin points $H Sk 1$, $H Sk 2-H Sk 8$ are joined by a line which represents the actual skin surfaces. The depth of any anatomical structure beneath the skin surface is measured from the skin line to the appropriate point. Thus distance $L-H Sa 1$ represents the depth of the first posterior sacral foramen beneath the skin surface.

XI Application of the Localization Charts

—The completed charts are turned over to the anesthetist-neuro-surgeon who applies them in the following manner: (1) The patient lies face down, or in whatever position may be necessary. (2) The vertical projection chart is placed over the patient's skin so that the localized skin points superimpose those tattooed on the patient's skin. (3) The localized anatomical structures are projected from the chart to the patient's skin and marked with surgical mercurochrome or similar easily

changes are greatly enhanced by the presence of infection in the renal pelvis. The roentgenographic findings are not always sharply defined in these cases; the shadows of renal calculi usually stand out clearly but those of osseous tissue may be difficult to detect, due to the indistinct outline, the insufficient amount of calcium salts, or the masking by the kidney tissue of surrounding structures.

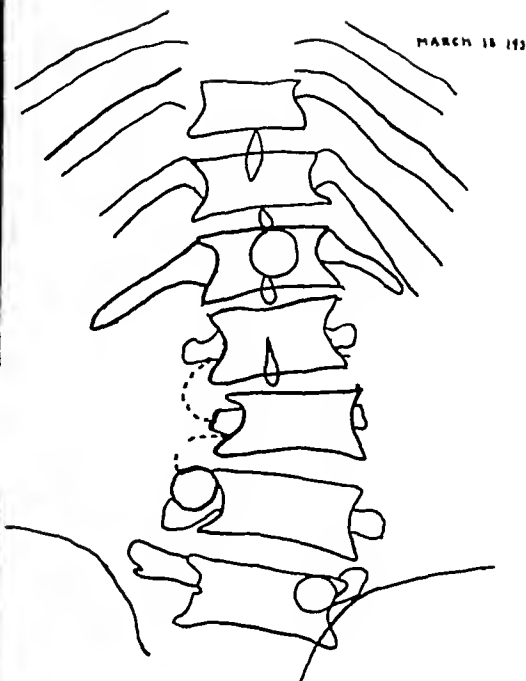
(C) *Renal Tumors* 1 *Cysts and Perirenal Tumors*—Bone formation has also been described in other diseases of the kidney and surrounding tissues. Phemister (1923) stated he has observed partial replacement by bone of calcified areas in renal tuberculosis. Kronlein and Wys have described a case of ossification of the walls of a cyst of the kidney in a woman 37 years old. The cyst was of the hemorrhagic type and contained blood clots and cholesterol crystals. Pick has reported the presence of osseous tissue in the calcified wall of a dermoid cyst. Campbell has pointed out that unusual shadows of bone or cartilage in the renal region may be present in the roentgenogram, and are suggestive of teratoma. In a case of pararenal teratoma in an infant, he observed similar roentgenographic shadows which, on gross and microscopic examination of the tumor, revealed cartilage but no bone.

Heincke (1909) reported a case of osteoplastic metastases in the retroperitoneal adipose tissue about the kidney from a primary sarcoma of the femur. The plain roentgenogram showed a large calcified shadow, about the size of a dollar, and several smaller shadows in the region of the left kidney. At autopsy, a flat hard platter formation of whitish-yellow tumor tissue of bony consistency was found in the region of the left kidney, and behind this there was another metastatic tumor, about the size of an apple and of bony consistency. In 1936, Weber reported an osteochondrosarcomatous tumor surrounding the left kidney and adrenal gland in a 15-year-old girl. The roentgenogram showed a calcified shadow in the kidney region. A similar tumor was found in the

femur and was probably the primary growth.

2 *Hypernephroma*—Ossification has also been reported in other types of kidney tumor. Albrecht (1905) reported a very interesting case of hypernephroma of the left kidney, with calcification and ossification, removed from a woman 58 years of age. Fabricius (1911) removed a cystic tumor of the kidney which contained nests of hypernephromatoma cells from a man 55 years old. The tumor had a dense, sclerotic, fibrous capsule in which calcification and bone tissue formation had occurred. Phemister (1923) stated that he had observed partial replacement by bone of calcified areas in a hypernephroma. In the same year, Baroni reported a case of hypernephroma with partial osseous metaplasia of the stroma, and cited similar reports by Pochanissky and by Gierke and Frankel in the literature. Federoff (1924) reported an interesting case of tumor of the lower half of a fused supernumerary right kidney, in a female 53 years of age, which showed calcification in the periphery and osseous tissue at the base and in central portions of the tumor.

Arkin (1926) reported a case of calcified and partly ossified hypernephroma of the left kidney, in a woman 46 years old, which is presumably the first case diagnosed roentgenographically during life. In 1921, a case of calcification and ossification of a hypernephroma (Case XIV) was observed by the authors, and a correct pre-operative diagnosis was made. This case is now reported for the first time. Moro (1933) described a case of ossification in a hypernephroma in a female 41 years of age. In each case, the osseous changes were noted in or about areas of necrosis, hemorrhage, or cystic dilatation. The presence of such changes within the kidney tumor may be the cause or result of an interference with the blood supply of the tumor, with the subsequent development of necrobiotic changes within the tumor, which provide a fertile soil for the deposit of calcium salts and an osseous metaplasia of the stroma elements. It is generally agreed that the osseous



Figs 10 A and 10 B Representing the x ray plate and a "processed" plate from an experimental case. Observe the curvature as well as the relative sizes of the transverse processes. The dotted lines represent masses of osseous osteoproliferative tissues compressing the corresponding nerves. They are certainly equal in size to the transverse processes and their positions without x ray localization would make blocking hazardous.

This process is repeated until a sufficient number of points along the curve are plotted to form a curve, the "standard depth curve."

INDICATIONS

After becoming better acquainted with the necessity for the use of x-ray localization in connection with various neuro-surgical procedures, especially therapeutic regional anesthesia and nerve block, the usual question arises as to just what type of conditions are amenable to this form of surgical relief. Without encumbering the reader, we will briefly summarize as follows:

The surgical relief of pain is no longer an experimental procedure. Physicians and surgeons facing the problem in which the pain syndrome is the outstanding factor no longer are apt to assume the attitude of passive expectancy. The necessity for efficient relief of the pain syndrome in various conditions became a well-recognized fact.

Under given conditions, the use of therapeutic nerve block in connection with the relief of various forms of pain presents definite advantages over other methods of surgical technique. For example, in such conditions as precordial pain, accurately performed therapeutic nerve block of the peripheral and sympathetic trunks will greatly assist in proper management of the patient. Yet it will not mask those sensations which could be considered as warning signals, and so the patient, although relieved of the agonizing pain, will perceive a certain amount of constriction during the cardiac attacks, which sensation will serve as a warning.

In instances of causalgia and reflex contractions, when the pain is unbearable and does not yield to even the most advanced therapeutic measures, surgical resection included, properly performed paravertebral nerve block and chemico-surgical neurolysis will not only relieve the pain and assist in speedy rehabilitation, but it will

trophic calcification associated with chronic degenerative lesions of the kidney

3 Metastatic calcification of the kidney ("*Kalkmetastasen*" of Virchow) occurs in various destructive bone diseases, *ie*, osteitis fibrosa cystica, osteomalacia, osteopsathyrosis, osteosclerosis, myeloma, etc, which are accompanied by a hypercalcemia. The essential factor in this type of calcification is the increase in the calcium content of the blood due to absorption of calcium salts from the bone lesions. The vast majority of these cases develop in the absence of a renal lesion.

4 The non-metastatic type of calcification ("*Kalkgicht*" of Schmidt) is associated with an acute or chronic inflammatory disease of the kidney. The renal lesion may be primary (chronic nephritis or arteriosclerosis), or secondary (toxic degenerative nephrosis). This type of calcification was observed in individuals with a normal blood calcium, although the degree of calcification is more marked when associated with a transitory or permanent hypercalcemia. The essential factor in this type of calcification is a calcium retention resulting from an impaired renal function caused by a nephritis, usually of the chronic type. The excessive excretion of albumin by the damaged kidney produces a disturbance of buffer properties of the blood, albumin, and phosphates, and decrease in the solubility of the calcium salts of the blood, conducive to the precipitation of these salts in the damaged kidney.

5 The dystrophic type of non-metastatic calcification is associated with a chronic destructive or degenerative lesion of the kidney, *ie*, pyonephrosis, abscess, tuberculosis, neoplasm, etc. This type of calcification is directly dependent upon local retrogressive changes, *ie*, faulty infiltration, hyalinization, necrosis, etc. The degree of calcification is influenced to some extent by degree of vascularity, the phosphatase activity of the tissue, and the amount of calcium in the blood and tissues.

6 Many of the areas of calcification of the metastatic and dystrophic types are readily discernible in the roentgenogram. The former variety are usually seen as radiable streaks or patches in the pyramids in close proximity to the calices, whereas in the latter variety the calcified areas are irregular and scattered throughout the renal parenchyma.

7 In our experience, calcification in a renal neoplasm may be considered a favorable sign.

8 Ossification of the kidney is a rare pathological finding and is usually associated with destructive or neoplastic diseases of the kidney. The formation of bone in the kidney is the result of osseous metaplastic changes in the connective tissue beneath the pelvic epithelium in the case of renal calculi, or in the stroma of the affected areas in the case of tumors, cysts, pyonephrosis, etc.

the repetition of the procedure at will should the indication warrant. The blocking technic, especially when x-ray localiza-

always be performed prior to such resection, in many instances it will bring about the desired relief, serving in other instances



Fig 12 X ray plate from experimental case. The blocking needles are in their proper position in the sacral foramina. The depth to which the needles were advanced was precisely defined by our method. Note the danger of blocking needles passing through the sacral foramina to pierce and damage the pelvic structure if the depth has not been previously defined with accuracy.

tion is employed, is so precise and accurate that the degree of failure or danger is lower with therapeutic blocks as compared with the more radical surgical methods.

During the treatment of narcotic drug addiction disease cases and in cases in which indication exists for speedy withdrawal of the drug, a properly administered therapeutic nerve block supported by deep sympathetic nerve block will fully control the major part of the withdrawal syndrome and assist in speedy, yet safe, rehabilitation.

In circulatory disturbances in diabetes, etc., when the circulation in the part affected is poor and when there is an indication for one or another form of sympathectomy, therapeutic nerve block should

as an index of what could be expected from surgical resection.

In various orthopedic conditions in which existing pain syndrome hinders the recovery either because of actual pathology referable to the nerve trunks or because persistence of such pain syndrome prevents the application of the usual therapeutic measures, a proper type of therapeutic regional anesthesia will relieve the patient of the distressing pain, secure his co-operation, and permit the routine treatment to be fully beneficial.

Of course it goes without saying that the various measures spoken of should not be considered as a panacea, nor should they be promiscuously applied. Before any method of treatment is recommended the

trophic calcification associated with chronic degenerative lesions of the kidney

3 Metastatic calcification of the kidney ("*Kalkmetastasen*" of Virchow) occurs in various destructive bone diseases, *ie*, osteitis fibrosa cystica, osteomalacia, osteopsathyrosis, osteosclerosis, myeloma, etc, which are accompanied by a hypercalcemia. The essential factor in this type of calcification is the increase in the calcium content of the blood due to absorption of calcium salts from the bone lesions. The vast majority of these cases develop in the absence of a renal lesion.

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LOGY

Methods of Diagnosis in the Treatment of Pain
Technic and Therapeutic Indications *Anesth and
Analg*, May-June 1936, 15, 128-134, and July-August,
1936 15, 162-163

(13) KAUFMAN, J Planeography Localization
and Mensuration "Standard Depth Curves" *RADI
OLOG*, August, 1936, 27, 168-174.

(14) DOGLIOTTI MARIO A Chirurgia del Nervo
trigemino e del Nervo Facciale *Atti della Societa
Italiana de Chirurgia*, Oct 14 1936

(15) TRIVELLINI, A L'anestesia nelle lesioni
traumatiche della pratica civile *Giornale Italiano di
Anestesia e di Analgesia*, September, 1937 Year III,
No III, p 227

(16) GREENE, M B Localizzazione radiologica
delle lesioni traumatiche dei nervi e loro diagnosi e
trattamento *Giornale Italiano di Anestesia e di
Analgesia*, December, 1937 Year III, No IV p 427

eventually destroy large areas of the surface epithelium. During this period there is an influx of histiocytes and polymorphonuclear cells (7). There is a gradual breaking down of the lymphocytes, and the histiocytes set about to effect fibrous repair or to develop into macrophages engulfing bacteria and cellular debris.

The engorgement of the mucosa interferes with proper function of the cilia, and eventually stasis is brought about, later, large surfaces containing cilia are destroyed and slough out. When the infection becomes chronic the entire cavity frequently becomes filled with engorged membrane, or at least the swelling is sufficient to close the ostium and to prevent drainage.

Bacteria are found in large numbers deeply buried in the tissues as well as along the surfaces, a fact which alone shows the futility of topical applications or the instillation of antiseptic solutions into the sinus cavities. Some means must be employed to stimulate the normal activities of the histiocytes and macrophages toward destruction of the bacteria, and repair.

In 1934 the authors published briefly their findings on a series of experimental animals (6). The frontal sinuses of the cat have been found to correspond very accurately with those of the human. Fenton and Larsell (7) have devised a very successful technic by means of which they can be infected and the infection maintained until changes comparable to those of chronic sinus disease in the human can be developed. Under the direction of Dr Larsell, head of the Department of Anatomy of the University of Oregon Medical School, a number of cats were thus infected, and when the infection became "chronic," half of the animals were irradiated and then autopsied at varying intervals, each with its control. The membranes were then carefully prepared and studied by him, and the findings were practically identical with those of other observers who had worked with irradiated tissues from infected areas elsewhere in the body.

The cat membranes examined following

exposure to the roentgen ray showed early destruction of the lymphocytes. The macrophages were also found earlier and in greater numbers than in the untreated controls which had been similarly infected. In no case was there evidence of injury to any of the normal cellular elements as the result of irradiation, though one group had been given twice the amount of irradiation used in the treatment of patients. Normal ciliated membrane was found in those cases in which healing had taken place.

The above described changes explain the rationale of roentgen therapy in these cases. The early influx and destruction of lymphocytes with the liberation of the antitoxic substances that they are thought to contain, together with the early appearance of macrophages in greater numbers, intensify the usual reaction to the infection and hasten repair. This explains the reaction that occurs several days following treatment. The patients usually notice an increase in nasal discharge and other sinus symptoms, beginning a few days after treatment and lasting for three or four more days.

We do not hold that roentgen therapy is applicable to any and all types of sinusitis. We are well aware that a good percentage of acute cases frequently clear up spontaneously or yield readily to conservative methods. We realize that certain factors are capable of producing sinus reactions and these must be treated by appropriate measures. It goes without saying that a syphilitic involvement requires proper antisiphilitic therapy and should not have irradiation.

Our efforts to relieve atrophic sinusitis have not met with success, likewise, we have seen no benefit from x-ray irradiation of cysts or polypi. Several of our patients have been irradiated following the removal of polypi in an effort to prevent recurrence, so far, the treatment has been successful in that respect.

The presence of a cyst, co-existent with hypertrophic membrane and other sinus symptoms, does not retard resolution of the other pathologic conditions following

- (7) GREENE, M B , KAUFMAN, J , and PIERSON, H Therapeutic Nerve Block Anesthesia and the Family Physician Am Med June 1933, 39, 250-267
- (8) LICHTEINSTEIN, PERRY M and GREENE M B Justifiable Addiction and Nerve Block Jour Nerv and Ment Dis , May, 1934 79, 534-539
- (9) DOGLIOTTI, MARIO A Trattato di Anestesia Unione Tip -Edit Torinese, Turin, Italy, 1935
- (10) LICHTEINSTEIN, PERRY M , GREENE, M B , and PIERSON H Therapeutic Nerve Block and Narcotic Drug Addiction Anesth and Analg Jan-Feb , 1935 14, 28-40
- (11) GREENE, M B , PIERSON, H , and LICHTEINSTEIN, PERRY M Il blocco nervoso nella terapia dell' assuefazione agli stupefacenti Giornale Italiano di Anestesia e di Analgesia April, 1935, Year I, No I, p 34.
- (12) GREENE M B , and PIERSON H Newer

will be a cross-firing of the ethmoids and sphenoids

For the ethmoids we use lead foil applied so that only the ethmoids on that particular side are unprotected. The central ray is again directed obliquely posterior, again cross-firing the sphenoids. The frontals are treated through lead foil with appropriate opening.

Each area is treated separately with due care not to overlap the skin previously exposed. All areas involved are treated the same day. We have found that better results have been obtained from the maxillary treatments when the ethmoids are also treated, if they show the least suspicion of infection. The factors we use are 120 kv p, 5 ma, $\frac{1}{4}$ mm aluminum filter, 11-inch distance for 10 minutes through each port. This amount of irradiation is equivalent to 700 r with back-scattering.

The patient is asked to report back in six or eight weeks, at which time a recheck is made. Of those persons who have obtained good results, we have found that the greater percentage required only the one treatment. If the sinuses have not entirely cleared up, but the patient has improved, further treatment may be given using due caution not to overtreat the skin.

During the past 18 months we have treated a series of cases using higher voltage and filtration (200 kv p, 20 ma, 0.75 mm copper, and 3 mm aluminum filter, 55 cm distance for 10 minutes through each of two ports). With this technic we shield one side of the face with lead except over the maxillary, ethmoid, and frontal sinuses on that side. The central ray is directed obliquely posterior, to cross-fire the deeper cells. The procedure is repeated from the opposite side at the same sitting. This dose is the equivalent of 530 r measured with back-scattering (450 r measured in air).

We have found that this technic gives results equal to the 120 kv p dose and has the added advantage of greater penetration and much greater protection to the

skin, so that further treatment may be given with a wider latitude of safety.

Both of the technics mentioned above apply only to adult patients with chronic sinus disease. When dealing with acute involvement or in treating children, the dose may be materially reduced.

There can be no guarantee against recurrence, but we have noticed that seldom is there a return of symptoms as severe as the original. Many of these patients have been able to withstand severe upper respiratory infection without a return of their sinus symptoms. Our first patient, treated several years ago, is employed by us, and we have watched her progress with interest. Thus far she has been able to throw off nose colds without again acquiring her old sinus involvement. We have treated many children by this method and the results have been uniformly good.² No effect on normal dentition has been observed.

From our experience with roentgen therapy in chronic sinusitis we are firmly convinced that it has a very definite place in the treatment of this widespread disease. In the hands of a skilled roentgenologist it is capable of accomplishing much good and is not harmful. It is worthy of wider consideration by rhinologists and radiologists than has heretofore been accorded it.

CONCLUSIONS

- 1 Seven years of experience in the use of the roentgen ray in the treatment of chronic sinusitis has convinced us that it has a definite therapeutic value in properly selected cases.

- 2 When skillfully applied it does no harm and causes no serious reactions, and there is no loss of time for the patient.

- 3 Failure of roentgen therapy in no way interferes with subsequent surgery should the latter become desirable.

² Since this paper was written an interesting article 'Roentgen Therapy of Chronic Sinusitis in Children,' has been published by Rathbone (Am Jour Roentgenol and Rad Ther July, 1937).

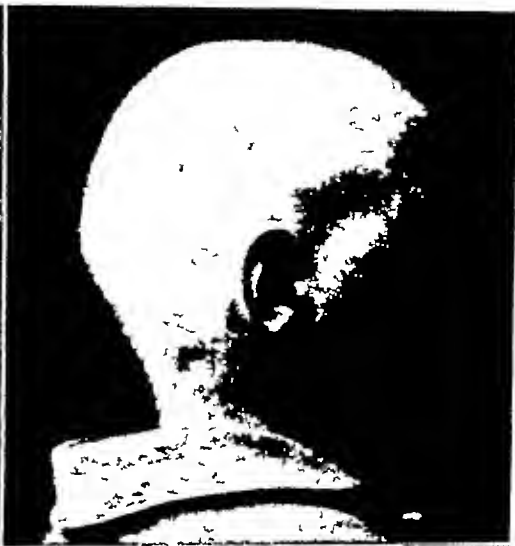


Fig 1 (*upper left*)
Fig 3 (*lower left*)

Fig 2 (*upper right*)
Fig 4 (*lower right*)

react with an accentuation of the vital phenomena and the climax of radiosensibility corresponds to the period of the hair growth, consequently, if we intervene during this period, the absorption of rays will be greater, and their cytolytic influence stronger. Successive

siderations intensify the local dystrophic manifestations, inducing gradually weaker reactions on the side of the cells, till at last they lose their reproductive power, so that the hair does not grow any more.

On this theoretical base we have founded the practical realization of our technic

PAIN ITS SURGICAL RELIEF AND THE RÔLE OF X-RAY LOCALIZATION THEREIN

By MARIUS B. GRFENE, M.D., and JULIUS KAUFMAN, M.D., *Brooklyn, N. Y.*

ALTHOUGH pain as a syndrome may be said to have existed since the world began, in contrast to other sensations it can be defined as a sensation of exception, or scientifically speaking, one of pathology. It is true that the pain syndrome possesses certain educational properties and appears as such especially in childhood and infancy when the movements and the life of adaptation begin. Notwithstanding this fact, however, pain in itself does not enter into the realm of those functions which are said to be absolutely necessary for normal life. We all know that normal adult life may be free from pain for a long period of time, this in itself can serve as an argument for the necessity of the existence of such sensation as pain. In some instances unquestionably the duty of pain is to signal to our conscience the existence of some stimulus which is damaging to the organism, and its purpose is to induce, even before conscious sensation, those immediate defensive reflex mechanisms which are at the disposal of the living tissues.

As a result of much research and various investigations, among which the work of Lugaro is outstanding, the following conclusions can be drawn. Pain in a strict sense is produced by stimuli which threaten the integrity of the tissues, and although to certain forms of pain we can assign a useful defensive function, often pain is an excessive reaction, paraphysiological, useless and damaging, provoked by destructive stimuli to which the organism cannot produce adequate protective response.

Combating such types of useless and damaging pain has been the aim of physicians and surgeons since time immemorial, but it has been only since the most modern methods of neuro-surgery were developed that true progress has been made in this respect.

We will not discuss here the technical aspects of various surgical procedures, but we wish to point out that on numerous occasions failure of success in various neuro-surgical methods related to the relief of pain has been due to lack of proper localization, both from diagnostic and therapeutic points of view. It was not until the co-operation of physiologists and roentgenologists was invited that several of the neuro-surgical procedures were lifted from the realm of art into the rank of precision and a scientific technic.

For the purpose of surgical relief of the pain syndrome, to be done irrespective of the underlying pathology, the present-day neuro-surgeon has at his disposal the most variegated procedures, among the more selective of which we will find the therapeutic nerve block. By basing our knowledge upon research and analytical data related to physiopathology of pain, we know that in order to surgically relieve the pain syndrome it is necessary to interrupt the conductivity in a sufficient number of peripheral or visceral nerve fibers supplying the given area to produce in this fashion the lack of excitability of sufficient strength so as to arrest the passage of an excessive number of impulses. Such an excessive number of impulses, when summated, are transmitted and received by the central nervous system in the form of pain.

The interruption of the conductivity in the nerve trunk by means of resection has several disadvantages. (1) The surgical procedure requiring an exposure of the nerve trunk is far from being simple. (2) In case of mixed trunks (composed of motor and sensory fibers) the separation of sensory fibers is never accurate and a great amount of motor fibers is also permanently destroyed, producing at its best more or less permanent motor weakness of the area



Fig 9 (upper left)
Fig 11 (lower left)

Fig 10 (upper right)
Fig 12 (lower right)

occur, even after a long period of time, in consequence of Curie therapy applied with a different therapeutic scope. In such

cases the skin appears atrophic, dyschromic, with telangiectases and zones of radio-epidermatitis and radiodermatitis, as

nerve blocking technic, but he must also know the exact location and depth of such bony landmarks as well as be able to localize

joints, bones, nerves, or chronically inflamed tissues, routine forms of treatment failed to produce the recovery, not because

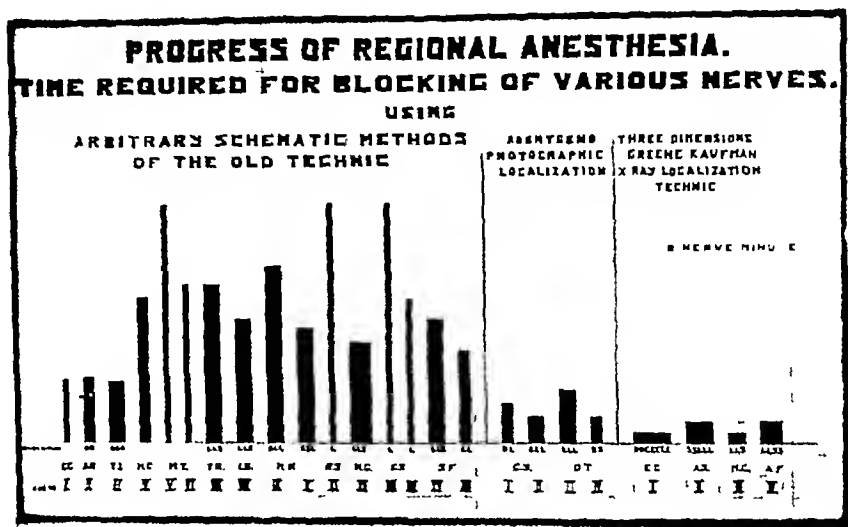


Fig 1 Represents a graphic chart showing the relative times required for blocking according to the old 'artful' method, and the modern scientific method of x-ray localization. Each column represents a case. The height represents the mean average per nerve. The width of each column represents the number of nerves blocked per case. The letter refers to the region block: (1) L, lumbar, (2) S, sacral, (3) D, dorsal, and (4) C, cervical. In certain cases the time required for blocking has been reduced by x-ray localization method from 30 minutes to two minutes.

such bony landmarks in their relation to the surface of the skin. Intraneural injections should be prevented as they are dangerous and will serve no purpose. Up to recent years the surgeon performing the blocking could depend only upon his sense of touch and empirically established localization of deep bony landmarks for the accuracy of his technic. Due to anatomical variations each case presented a separate problem (See Figs 9-A and 9-B).

Taking into consideration what we have said before, we can readily note the necessity for exact knowledge as to the location of bony landmarks and the associated nerve structures in connection with any type of surgery, but when it concerns neuro-surgery, especially in respect to the pain syndrome, such precise knowledge is imperative and indispensable for success. In numerous instances, especially in more or less chronic conditions associated with such pathologic changes as diseased spine,

the treatment was improper, but because the associated pain syndrome was not attended to properly and its continuous existence did not permit the patient to derive even the slightest benefit from the instituted treatment.

Modern neuro-surgery created new and improved methods for the treatment of such conditions. We will take as an example the patient who has been suffering from severe pain associated with chronic bursitis of the shoulder, a common occurrence following wrenching of the extremity. Unless the treatment is primarily directed toward relief of pain and secondarily toward joint and muscle rehabilitation, it will be met with failure. Any attempt at massage, passive or active motion, or even physiotherapy will be met with objection on the part of the patient unless the pain syndrome has been previously controlled. Relieve the pain and you will gain the confidence and co-operation of your pa-



and designated anatomical structures in relation to previously tattooed skin points. The Depth Chart defined the depth of these structures beneath the skin surface.

In 1936, one of us (J. K.) published "Standard Depth Curves," to be employed in localization procedures. Since then, the Depth Chart has been prepared in conjunction with these curves.

The advantages of localization charts for nerve block can be readily appreciated by consulting Figure 1, which is a graphic record showing the time consumed in three different surgical procedures of nerve block: (1) the Old Empiric Method, (2) the Roentgeno-photographic Method, (3) the X-ray Localization Method.

For simplicity's sake, this section has been divided into the following parts: I Anatomical structures designated by the anesthetist-surgeon, II application of the skin points, III preparation of the x-ray films, IV preparation of the v-ray table, V v-ray procedure, VI analysis and marking of the v-ray films, VII transcription of the v-ray data, VIII analysis of the transcribed data, IX vertical projection chart, X depth chart, XI application of the localization chart, XII derivation of the "Standard Depth Curves."

I The Anatomical Structures Designated by the Anesthetist-surgeon—Before the patient is to be "blocked," it is the duty of the anesthetist-neuro-surgeon to assemble and take into account all the necessary data regarding the particular case in question. He knows, too, which anatomical structures he will use as guides to facilitate the actual surgical procedure and designates them to the v-ray consultant as the ones to be localized. If, for example, the case is one requiring lumbo-sacral block, he will designate the transverse processes of the first, second, and third lumbar vertebrae, and the posterior first and second sacral foramina, five in all. These are the structures which will be of vital importance to him under the circumstances.

For any other blocking or surgical procedure, diagnostical charts or mensuration,

he will designate other anatomical structures. In other words, in any individual case, the anesthetist-neuro-surgeon designates those structures for localization which suit his purpose. After all, he is in a better position to know which structures he will employ to guide him than the roentgenologist, whose sole purpose is to prepare the localization charts from appropriate v-ray films.

II Application of the Skin Points—Points are tattooed on the patient's skin (1) to facilitate the localization of the designated anatomical structures, and (2) to act as guides for the application of the localization charts when the blocking is actually undertaken. In deciding where to place these skin points, we have found it expedient to adopt the following rules for guidance: (1) place a skin point as nearly as possible directly over each of the designated anatomical structures, (2) place a skin point above the level of these structures, (3) place a skin point below the level of these structures, and (4) place a skin point in any spot where there is an abrupt change of contour, or of direction.

In lumbo-sacral cases, we ordinarily use eight skin points. One is placed directly over each of the five designated anatomical structures. A sixth is placed above the level of the first lumbar transverse process. A seventh is placed below the level of the second posterior sacral foramen. The eighth is placed in the hollow of the back where there is an abrupt change of contour from back to buttock. Each of the skin points is designated by a number. In the lumbo-sacral cases, the uppermost is No. 1, the lowermost No. 8, the intermediate Nos. 2, 3, 4, 5, 6, 7 in succession. A small lead marker is strapped over each of the skin points so that the images of these points will be visible on the films when the v-ray exposures are made.

III Preparation of the X-ray Films—After the lead markers have been strapped to the skin points, two 14 × 17 in. screened films are prepared as follows: (1) To the first a lead numeral 1 is strapped along its upper border. This is called Film 1, (2)



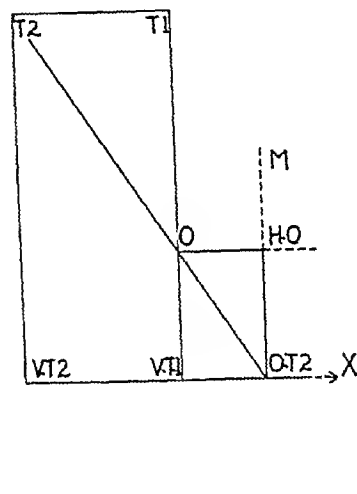
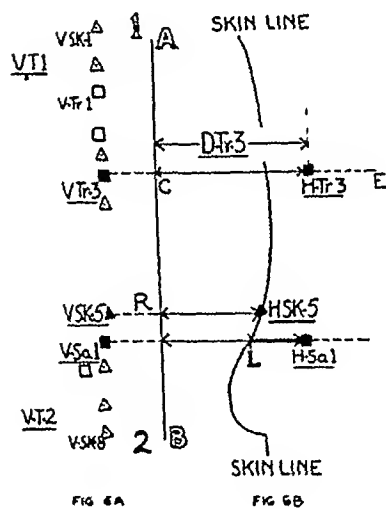
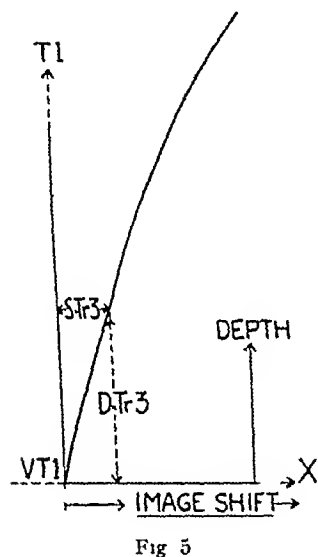
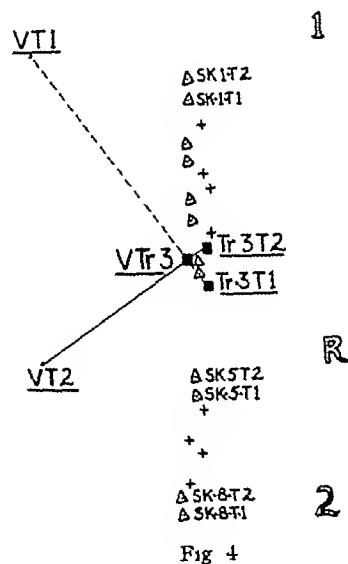
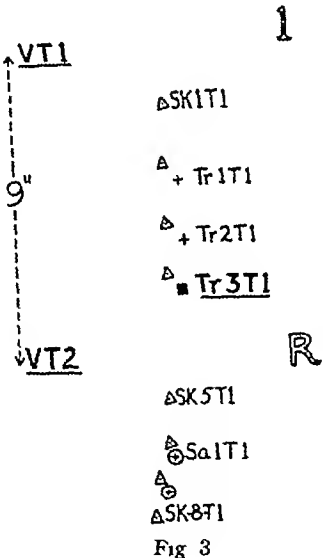
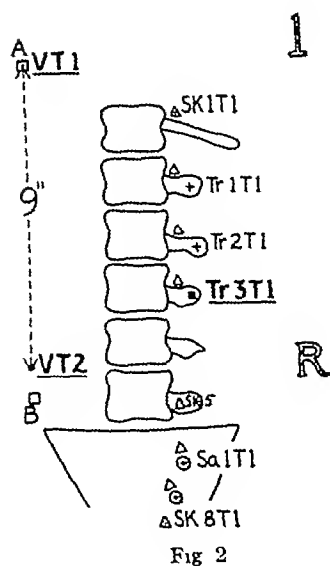
Fig 17 (upper left)

Fig 19 (lower left)



Fig 18 (upper right)

Fig 20 (lower right)



the illuminated film (2) Film 2 is then substituted (Fig 4), and the same transparent sheet superimposed over it so that the points VT 1 and VT 2 on the sheet correspond to the points VT 1 and VT 2 on the film. The other points are then transcribed.

III Analysis of the Transcribed Data
—On the transcribed transparent sheet (Fig 4) we note that there are present (1) points VT 1 and VT 2, (2) two ink spots for each of the eight skin points, (3) two crosses for each of the five designated anatomical structures.

One can readily see that the distance

separating each set of points varies from that separating any other set. Thus the distance Tr 3 T1—Tr 3 T2 is much greater than Sk 5 T1—Sk 5 T2. The distance separating each set of points we call the "image shift." The distance separating any individual set of points is denoted by the symbol *S*, followed by the symbol for that point. Thus, the image shift of the third transverse process would be designated "S Tr 3." The image shift, *S*, for any point is employed in conjunction with the "standard depth curves" to define the depth of that point above the plate level (Fig 5). By applying S Tr 3 along



Fig 25 (*upper left*)
Fig 27 (*lower left*)

Fig 26 (*upper right*)
Fig 28 (*lower right*)

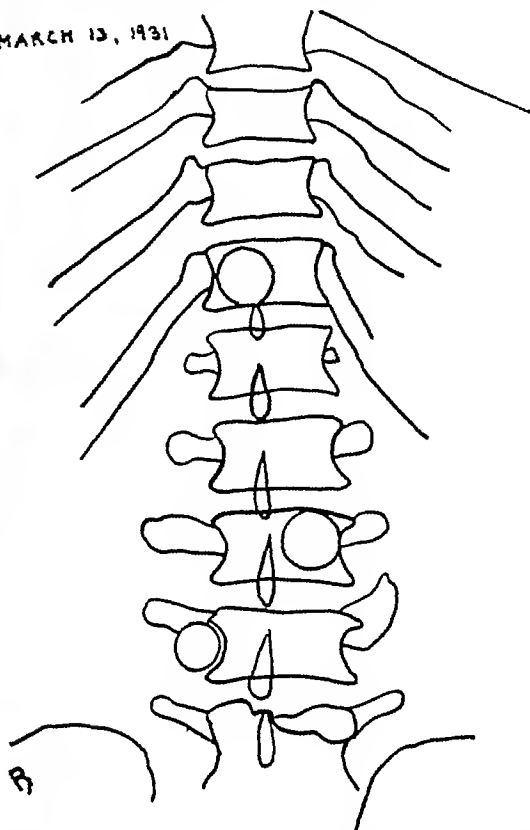
The same effects may be obtained in cases of local hyperhidrosis, especially if it be limited to the face, and particularly to the nose, gamma irradiation applied by means of molded apparatus gives us the possibility of obtaining in this region, too, an homogeneous subdivision of the dose in all the cutaneous and subcutaneous tissues

We have had the opportunity of observing some regions of the scalp which

had incidentally undergone epilation as a consequence of irradiation applied to neighboring regions. We thus had the possibility to state a fact which is very important from a radiobiological point of view: white hair falls and is replaced by darker, thicker and often curly hair even in subjects more than 70 years of age. (See Figs 21-25.) This growth of dark hair, replacing the fallen white hair after a gamma irradiation applied at the epila-



MARCH 13, 1931



Figs 9-A and 9-B Representing γ -ray plate and processed plate from a patient submitted to nerve blocking. Note the relative difference in size of the first and fourth lumbar transverse process. Without γ -ray localization the blocking procedure in such or similar cases would be met with failure.

visible skin preparation. The depth of each of these structures beneath the skin is obtained from the depth chart.

If a needle were inserted through a surgical mercurochrome skin point to the appropriate depth, it would strike the anatomical structure in question.

II The Derivation of the "Standard Depth Curves"—In all systems of localization by triangulation it is necessary to make two γ -ray exposures. If the factors employed in the localization procedure (1, target-film distance, 2, target-shift distance) are known a 'standard depth curve,' the height of the object in question above the plane of the γ -ray film, may readily be determined (Fig 5) by applying the image shift along the horizontal axis and reading the depth along the corresponding vertical axis.

Since in this section we employ "standard depth curves" to define the depth chart, we have thought it advisable to

demonstrate how these curves are plotted. If, for some reason, one should wish to change the two known factors employed in the γ -ray exposures, a new curve could then be plotted, employing the changed factors. The "standard depth curves" are plotted in the following manner (Fig 7): (1) Rectangle $T_2-T_1-V T_1-V T_2$ is drawn, and is designated by the special name "depth localization rectangle." (T_2-T_1 is made equal to the target-shift distances, $T_1-V T_1$ is made equal to the target-film distances). (2) Any point O , along $T_1-V T_1$, is selected. (3) Line T_2-O is drawn, and extended to intersect line $V T_2-V T_1-X$ in $O T_2$. (4) At point $O T_2$, line $O T_2-M$ is drawn perpendicular to $V T_2-X$. (5) Along line $O T_2-M$, line $O T_2-H O$ is drawn equal to distance $V T_1-O$. (6) Point $H O$ (horizontal projection of O) represents one of the points on the "standard depth curve."



Fig 33 (upper left)

Fig 35 (lower left)

Fig 34 (upper right)

Fig 36 (lower right)

served a partial growth of hair, limited to the irradiated region, on the same side we observed the growth of some hairs of the eyebrow (Fig 28). The second irradiation was applied to the left half of the scalp, but not on the whole surface of this region. Hair grew only in the irradiated zone, the part that had not been irradiated was still hairless. After this irradiation the left eyebrow was also restored. Menstrual disorders (dysmenorrhea) were controlled (Figures 29 and

30, Figures 31 and 32 show condition after the second irradiation of the scalp). The way in which this case reacted to the radio-active irradiations applied by us is worth some biological consideration.

First of all, it appears that gamma rays have a direct local therapeutic influence. The hair grew only in the irradiated regions. This influence may extend to more distant zones of the same side of the body, as we may see by observing the growth of the eyebrow. The irradiation has also un-

also produce improvement in circulation in the parts affected

In various forms of neuritis or neuralgic

In instances of essential hypertension in which the conditions do not yield to the routine therapeutic measures, a preverte-



Fig 11 Representing three dimensional x ray localization plate from a patient suffering from post traumatic spur in the fifth and fourth lumbar regions Without x ray localization a proper type of nerve block would be difficult The triangular marks represent the lead markers strapped over tattoo marks prior to exposure of the plate The two square markers on the opposite side of the spine represent target points at which each individual exposure was made The three-dimensional x-ray localization plate is prepared from such x rays and serves for exact and accurate application of nerve block

pain syndrome, developed as sequelæ of such traumatic injuries as, for example, strains in the lumbar region or post-traumatic injuries to other component parts of the spine and back, a therapeutic nerve block performed by fractional method will quickly bring about the desired recovery

bral therapeutic nerve block of splanchnics or of semilunar ganglia not only will secure the much desired lowering of the blood pressure, which improvement will be relatively lasting and will compare most favorably in this respect with the more advanced surgical technics of sympathetic resection, but it also will permit



Fig 41 (upper left)

Fig 43 (lower left)

Fig 42 (upper right)

Fig 44 (lower right)

neurovegetative system shall have acquired its full balance (See Figs 33-42, inclusive)

After all the experiences we had in this field, we came to the idea of treating premature baldness, which grieves men perhaps still more than facial hypertrichosis does women

Our first results in this field were very favorable, after a period of defluvium which takes place particularly in cases accompanied by seborrhea, the hair grows

in greater quantity than before, and white hair is substituted by dark wavy or even curly hair. Our colleagues, who were affected by baldness, were numbered among our first subjects, they were well satisfied with the results we obtained and are to-day the most convinced advocates of this therapeutic method, which they recommend as an absolutely harmless and very efficient one (Figs 43, 44, 45, and 46)

Thus a new way is open in this field to

patient should be thoroughly neurologically examined and various electro-diagnostic tests, as, for example, galvanometric

It not only does not detract from the value and importance of any of the procedures, regional anesthesia included, but by sim-

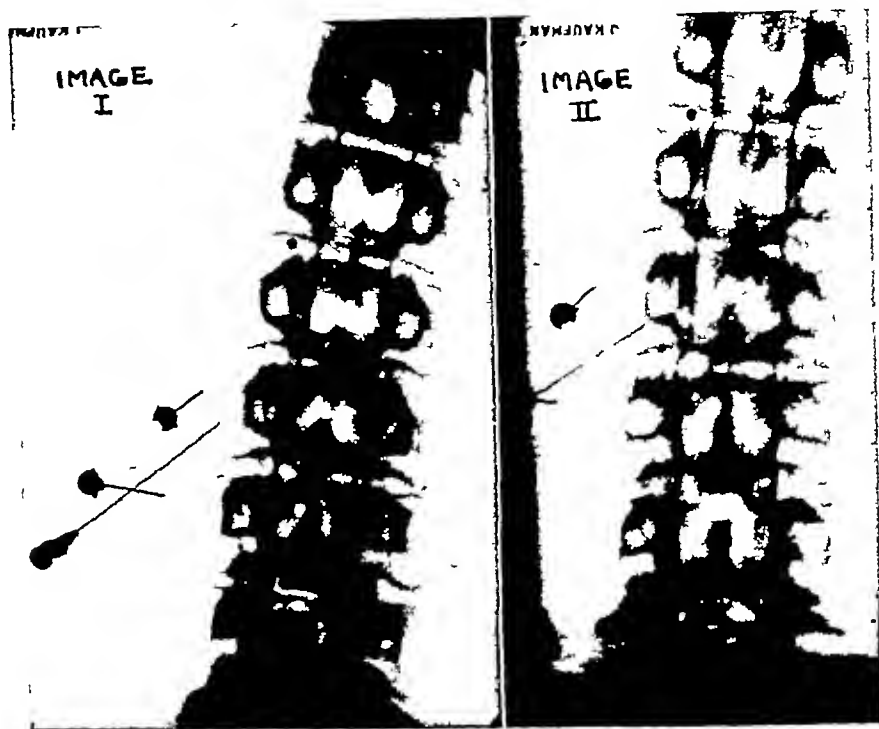


Fig 13 Observe upon Image I the correct position of needles for nerve blocking In Image II the blocking needle is easily advanced beyond the proper position if there is a lack of exact knowledge for guidance

skin temperature recording, dynamometric tests, summation of stimuli test, conduction test, skin resistance test, etc , should always be performed in addition to the routine laboratory and x-ray examinations of the spine and the parts affected Only by proceeding in such manner can successful and lasting results be secured

CONCLUSION

In conclusion, we wish to state that the x-ray localization method is so simple, and its advantages in the surgical treatment of the pain syndrome in general and in therapeutic nerve block in particular are so evident, that no plea for its use in these procedures is necessary It introduces into the field of neuro-surgery and regional nerve block a scientific method which permits individual correctness of application

plifying the same it extends its field of usefulness and applicability

(M B G) 1519 President Street
(J K) 201 Eastern Parkway

REFERENCES

- (1) SAPIESKO B, and GREENE M B Summation of Stimuli in Nerve Trunk Conduction Arch Exper Path, Moscow, 1912, 4, 9
- (2) KUNZ, F, GREENE M B, and CARVAJOL-FORRERO J Identification and Classification in Crystallography H Altenburg Limburg 1924
- (3) LABAT GASTON and GREENE M B Diagnosis and Treatment of the So-called Sciatic Neuralgias Am Jour Surg, March, 1931 11, 435-451
- (4) GREENE M B Electric Percussion Hammer as a New Aid in Diagnosis of Peripheral Nerve Irritability Med Jour and Rec, Feb 17, 1932 135, 194, 195
- (5) Idem Regional Anesthesia—Its Modern Technic and Therapeutic Application Calif and West Med June 1932 36, 389 and July 1932, 37, 15
- (6) GREENE M B and KAUFMAN, J Anesthetic and Therapeutic Nerve Block by Three Dimensions X ray Localization Method Anesth and Analg, Nov -Dec 1932, 11, 241-251

DOSAGE, DURATION OF TREATMENT, AND REACTIONS IN PROTRACTED FRACTIONAL ROENTGEN TREATMENT, WITH SPECIAL REFERENCE TO CARCINOMA OF THE UPPER AIR PASSAGES¹

By JENS JUUL, M D,² Chief Radiologist, Radium Center and Finsen Institute, Copenhagen, Denmark

IN the years 1931-1935 there were referred to the Radium Center in Copenhagen, in all, 151 cases of malignant epithelial tumors (sarcomas not included) of the hypopharynx, rhinopharynx, tonsil, base of tongue, and larynx. Of these, 41

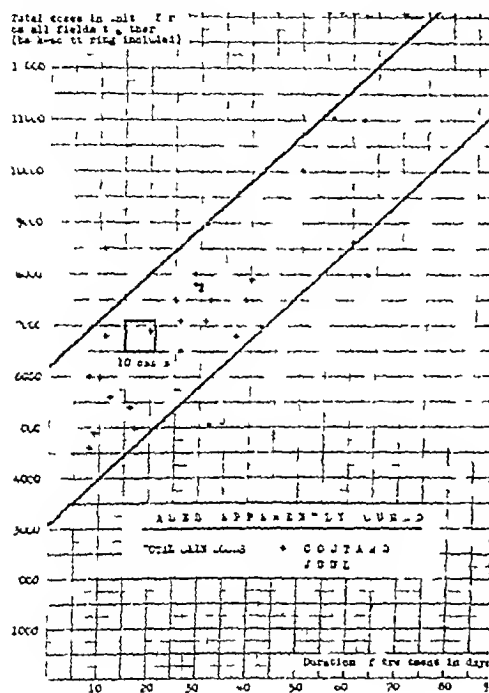


Fig 1

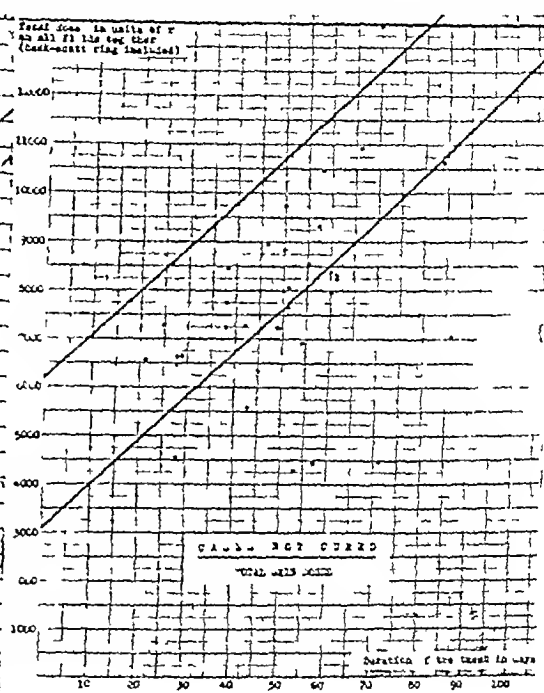


Fig 2

TABLE 1—TOTAL NUMBER OF CASES REFERRED, AND NUMBERS STILL SYMPTOM-FREE IN 1937

Referred	1931	1932	1933	1934	1935	Total
Hypopharynx (extrinsic larynx)	10-2	14-3	14-6	11-1	9-1	58-13 = 22 per cent
Rhinopharynx	5-3	2-0	7-2	7-3	7-1	31-9 = 32 per cent
Tonsil	5-2	9-2	4-1	7-1	6-3	31-9 = 29 per cent
Base of tongue	4-0	1-1	4-1	1-1	2-0	12-3 = 25 per cent
Larynx (intrinsic)	2-0	1-0	6-2	7-2	6-3	22-7 = 32 per cent
	26-7	27-6	35-12	33-8	30-8	151-41 = 27 per cent

¹ Presented before the Fifth International Congress of Radiology at Chicago, Sept 13-17 1937

² On Feb 6, 1938 Dr Jens Juul died of a severe attack of otitis. His Danish colleagues and the Danish League against Cancer regret the loss of a very able man who has given valuable clinical and scientific contributions to modern roentgen therapy. H M H

(27 per cent) remain apparently cured in 1937. The cases free of symptoms are distributed with fair equality over the different years and among the different localizations. The therapy has been protracted fractional roentgen treatment, in only three

BIOLOGICAL INFLUENCE OF GAMMA RAYS ON THE GLANDULAR AND HAIR SYSTEM OF THE SKIN IN NORMAL AND PATHOLOGICAL CONDITIONS¹

By PROF VINCENZO PALUMBO, *Florence, Italy*

THE biological influence exerted by radio-active rays on the skin and its glandular and hair system could be thoroughly studied on account of the easy direct observation of this tissue during all the phases of its reactive period

The skin, considered as an organ in itself, does not passively endure any stimulation applied on any part of its surface, but presents various local and general reactions. Consequently, when we irradiate some part of our body through the skin, we must consider separately the biological reactive symptomatology of the skin in the irradiated zone, in the other parts of that skin region, and in other organs

The study of distant reactions is peculiarly interesting whenever we regard the skin as the only way by which the influence of rays is transmitted, or when we take into consideration another factor, that is, the endocrine sympathetic system

Let us consider now the way in which the different structures annexed to the skin react to the influence of radio-active rays

First of all, let us observe the reaction of the hair system in normal and pathologic conditions, without obviously losing sight of the sebaceous and sudoriferous glands of the skin

Since we are going to speak about the influence that rays exert on the skin, we shall first briefly mention the classic skin erythema which was considered in the past as a biological sign determining the efficiency of different doses of rays. As I have already had the opportunity of stating many times, the skin erythema is not an absolute biological test, in fact, this sign is not a constant one, as it depends upon different local and general conditions

On the contrary, when we employ radium, applying it on a hairy region, as for instance the scalp, a dose of gamma rays from different crossed fields and by means of a molded apparatus according to the technic already described by me (since 1919), we always observe a constant biological reaction, that is, the complete falling out of hair at the end of a three-week period after irradiation, though we do not observe any estimable clinical alteration of the skin

The growth of new hair, preceded by a *poussée* of thin down one month after the falling out of the hair, is a fact as sure as the defluvium itself, this statement is supported by the observation of nearly one thousand cases

An important fact that we state in connection with our study of the biological reaction is that the quantity of new hair is greater than that of the fallen hair, the new is stronger, and its color is darker (See Figs 1, 2, and 3)

In cases in which irradiation had to be repeated, as, for instance, in successive scab contagions, this reactive symptomatology was still more accentuated. Under the influence of radio-active radiations applied at an epilation dose, the hair root shows a sort of exalted reproductive functionality. The epilation dose has a siderating influence on the mother-cells of the hair papilla, with subsequent hair fall, the growth of new hair depends upon a local reaction of different, although always accentuated, intensity. This difference of intensity depends upon all the local and general factors determining every single mode of reaction (see Fig 4)

If we insist in irradiating successively during a certain period of time, we see that the hair papilla begins to react in a different way. The germinating elements

¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17, 1937

higher value than these may perhaps be a necessary condition for obtaining a cure, it is, of course, not sufficient to ensure it

curve, the speed of the elimination being at any given time proportional to the concentration of the "ray poison" at the

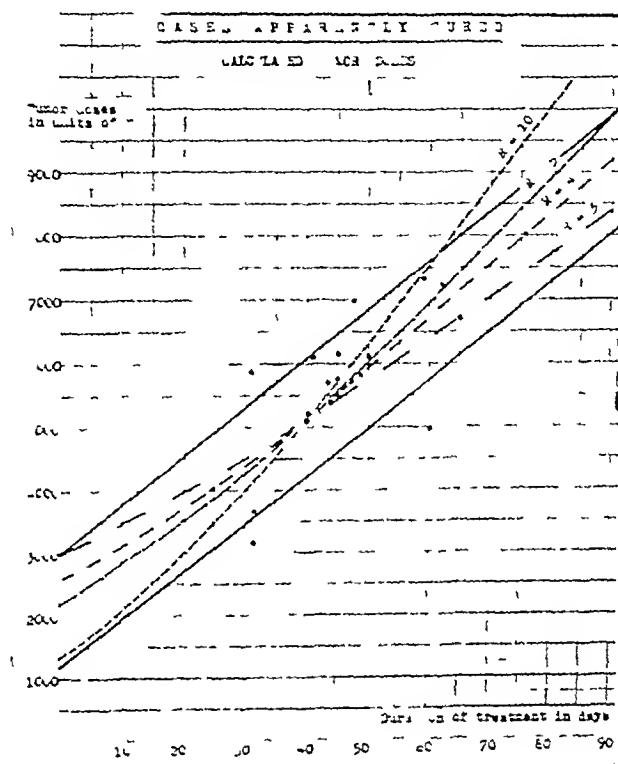


Fig 4

Next, I have calculated the doses in the tumor itself, for my own symptom-free cases, and plotted them in the same manner (Fig 3). It will be seen that most of them lie within a zone whose width corresponds to a variation in dose of 1,800 r, and again we see how the doses increase with the duration of treatment.

It seems to me that the necessity for an increase of dose when the treatment period is lengthened has a natural explanation in the possible capacity for recovery of the cancer cells from the ray lesion, and I have, therefore, tried to find out how these experiences may be made to fit with the Kingery-Pfahler theory concerning this recovery. As you know, the elimination of the "ray poison" from the tissues, according to this theory, follows a logarithmic

moment. The total doses which, if distributed evenly over a varying number of days should produce the same effect—or, to keep to the analogy of the "ray poison," the same concentration in the tissues—can be calculated by means of the following formula:

$$D_p = D_n \times \frac{p}{n} \times \frac{1 - (1 + R)^{-n}}{1 - (1 + R)^{-p}},$$

in which R is the rate of recovery per day, and D_p the total dose which, distributed equally over p days, gives the same effect as the dose D_n , if the latter is distributed equally over n days. The calculation will be exact only if the daily doses given have all been of the same magnitude. In my cases they have been so only approximately.

I have started from the dose 5,100 r in



Fig 5 (upper left)
Fig 7 (lower left)

Fig 6 (upper right)
Fig 8 (lower right)

of "cosmetical radium epilation in cases of feminine hypertrichosis"

The hair defluxium always occurs with out any clinically appreciable reaction on

the side of the skin. The long experience we have in this field allows us to state that this method does not produce any such skin alteration as might possibly

does not producing epithelitis, and for the mean values of the necessary tumor dose. If we look at the relation in which

perience that by extending the treatment over a period of six weeks or a little longer we make it far easier on the patient, with-

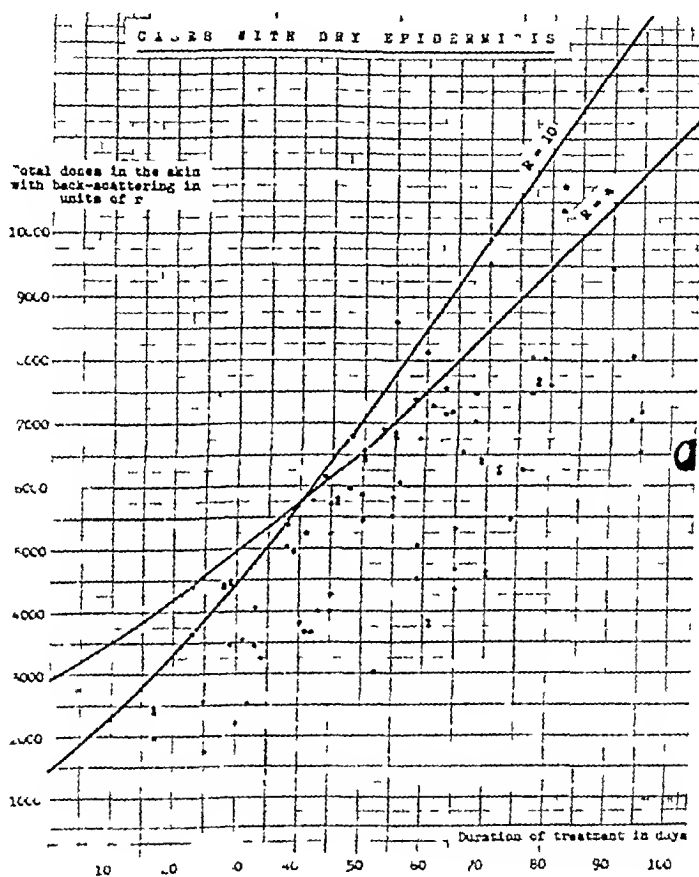


Fig 6

the curves lie to each other, we see that with a treatment time of less than three to four weeks it is not possible to make a tumor of medium sensitivity disappear without provoking exudative epidermitis or epithelitis. By extending the treatment over a longer period than four weeks it will, as a rule, be possible to avoid exudative epidermitis, and by extending it over a still longer period also the epithelitis may be avoided.

These partly theoretical estimates agree very well with our practical experiences. Considerable individual variations must be counted with, but it is my absolute ex-

perience that by extending the treatment over a period of six weeks or a little longer we make it far easier on the patient, without depriving it of any of its efficacy. That the selectivity thus increases with longer treatment time, can be explained on the theory that the different tissues have different speeds of recovery.

After this we cannot consider the production of epithelitis on the mucosa as the object to be aimed at with the treatment, or as a condition for cure. Several experiences speak against conceiving the epithelitis and the exudative epidermitis as due to a directly epithelicial effect of the radiation—as a matter between the epithelial cells and the γ -rays alone. To me it seems more likely that the irradiation



Fig 5 (upper left)
Fig 7 (lower left)

Fig 6 (upper right)
Fig 8 (lower right)

of "cosmetical radium epilation in cases of feminine hypertrichosis

The hair defluvium always occurs without any clinically appreciable reaction on

the side of the skin. The long experience we have in this field allows us to state that this method does not produce any such skin alteration as might possibly

THE APOPHYSEAL INTERVERTEBRAL ARTICULATIONS, ROENTGENOLOGICALLY CONSIDERED

By ALBERT OPPENHEIMER, M D , Beirut, Lebanon, Syria

From the Department of Roentgenology, American University of Beirut

I OBJECT OF STUDY

AS parts of the vertebræ, the apophyseal intervertebral articulations may participate in localized or systemic diseases of the spine either directly, when affections of the vertebral bodies spread to the articular processes, or indirectly, when by pathological positions of vertebræ abnormal stress is laid upon the articular facets. On the other hand, as true diarthrodial joints, these articulations may become affected by the various forms of arthritis primarily, independently, and exclusively. It has gradually become evident that this distinction is significant for the treatment. Since anatomical findings in these conditions are not easily available, an attempt is here made to reach an interpretation based upon comparison of different stages of these diseases, and upon their correlations with certain clinical manifestations. The clinical aspect of the investigation is discussed in a separate paper. This report is concerned with the roentgen findings, it is based upon examinations of 162 patients with various affections of the apophyseal articulations, and upon a re-examination of more than 2,000 roentgenograms of parts of the vertebral column.

II TERMINOLOGY

There is at present no uniformity as regards the classification of diseases of the spine. It is necessary, however, to come to some understanding about the significance of the terms in use. One may follow either an anatomical, an etiological, or a clinical conception. The clinical findings, as a rule, are not sufficiently distinctive (17), and an etiological classification is not yet possible (22), wherefore classification according to anatomical characters is at present preferable, though not final.

(1) *Spondylitis* is an inflammatory disease of the spine, spondylon, especially of the vertebral *bodies* either rarefying, as in tuberculosis, or hypertrophic, as in low-grade infections and in mechanical irritation, resulting, for example, from thinning of the discs.

(2) *Spondylarthritis* is an inflammation of the spinal *joints*, arthron, namely, the apophyseal intervertebral articulations, there being no other true joints in the spine.

(3) *Spondylosis ossificans ligamentosa* is determined by ossification of the spinal *ligaments*, especially in the absence of changes in the vertebral bodies, intervertebral discs, and apophyseal articulations.

By eliminating from this classification such clinical terms as are correlated with various anatomical entities (e.g., spondylosis muscularis, Bechterew's disease, and the like), it would be clearer and more exact to confine the terminology to the simple descriptive categories above mentioned.

III TECHNIC NORMAL APPEARANCE

Pathogenetically, the key structure of the apophyseal joint is the articular *cartilage* which is not directly visible roentgenographically. The width of the roentgenologic joint space and the appearance of the bony articular surfaces (facets) show indirectly whether or not the cartilage is affected.

Since the apophyseal joint spaces are quite narrow, deviations from a strictly perpendicular projection may lead by reciprocal overshadowing of the facets to superimpositions which are easily misinterpreted (Fig 2). The position and direction of the facets that enclose the joint spaces vary in the several sections of

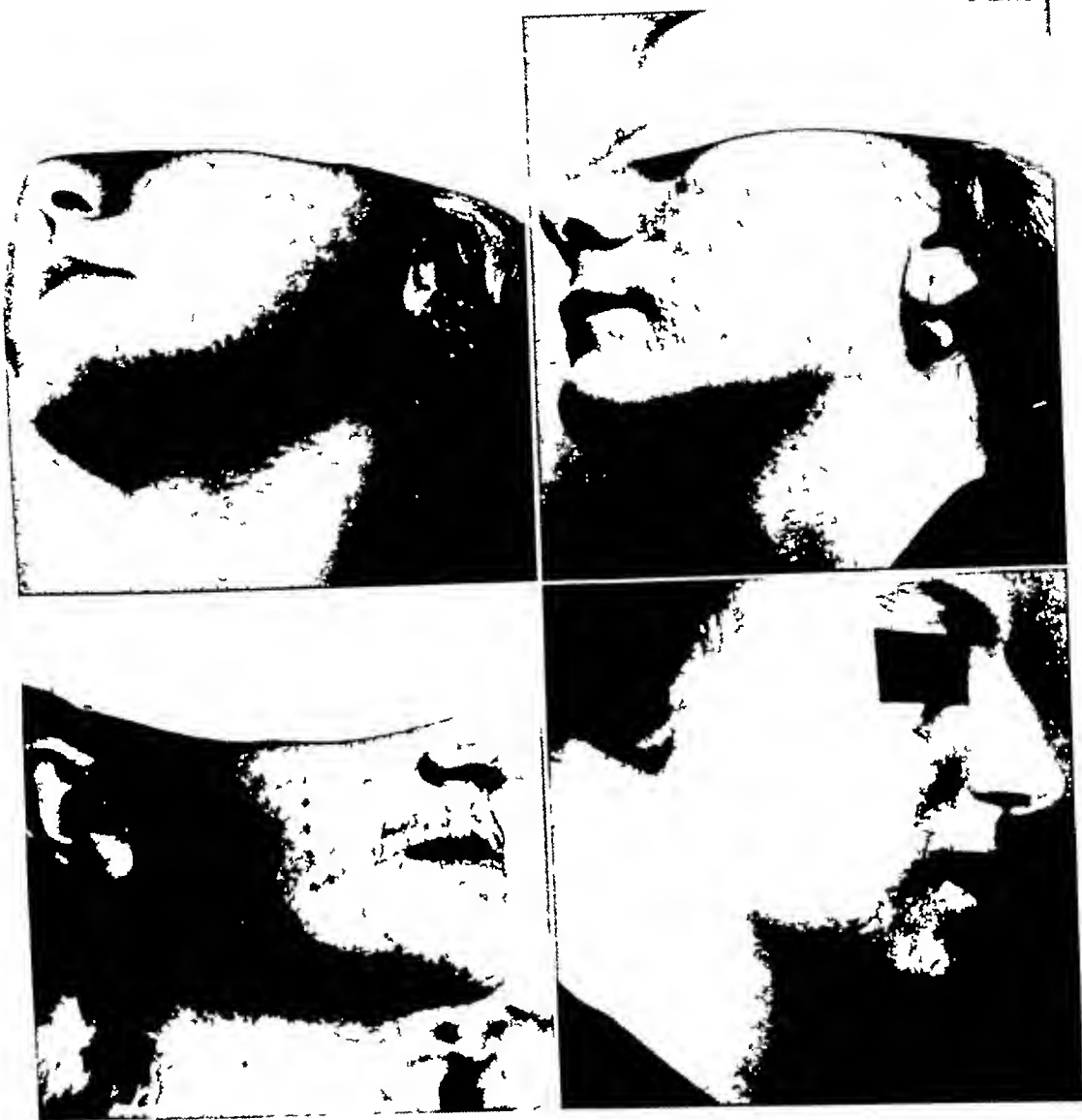


Fig 13 (*upper left*)
Fig 15 (*lower left*)

Fig 14 (*upper right*)
Fig 16 (*lower right*)

a consequence of an altered nutrition caused by the intensive irradiations it has undergone (Figs 5-16)

Rays pass uniformly through the skin, but their biological influence (that is to say, the absorption and the reaction of different parts of the skin) does not correspond to their physical homogeneity (quantity quality of the irradiation, and penetrating power). One given kind of irradiation may have merely an inhibitory influence on the physiologic function of

some structures, as for instance, the glandular tissue, whereas it is absolutely negative for connective tissue

The increased secretory activity of sebaceous and sudoriferous glands (steatosis and hyperhidrosis) may be relieved by even a single irradiation which does not directly influence the glands, but controls the activity of the neurovegetative system upon which depends the glandular function

Thus, in cases of acne vulgaris of the

The following description applies to the left apophyseal joint spaces. For demonstration of the left lumbar joint spaces,

and is slightly rotated forward so that his right breast remains raised to an angle of 70° , if the patient, in the same general

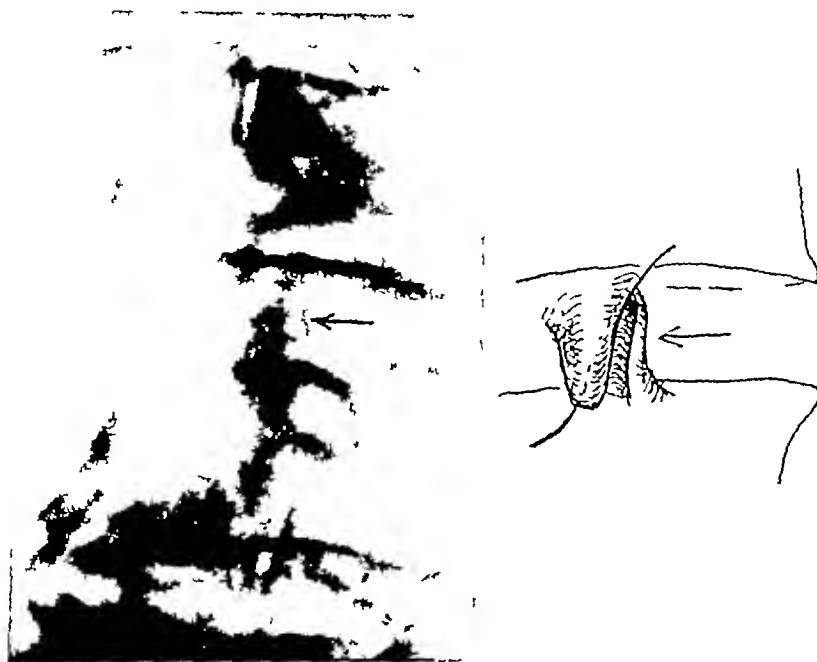


Fig 2 The direction of the facets of the fourth lumbar vertebra (arrow) differs from that of the fifth lumbar in this case. Consequently, the fourth apophyseal joint is overshadowed (false narrowing)



Fig 3-A

Fig 3-B

Fig 3 A flat piece of lead is inserted into a right dorsal apophyseal joint space. In 3 A the left transverse processes are rotated forward, the joint space projects perpendicularly (arrow). In 3 B, by backward rotation the shadow of the lead projects as a plane (arrow) showing that the joint space does not stand at right angles to the film. This confirms Bable's objection to Lange's method. Amount of rotation in either projection 20 degrees

the patient is placed with his back to the film, his left side being in contact with it, and his right side being raised to an angle of 45° . To show the left dorsal joints, he is posed with his left side to the film

position, is rotated backward so that his right scapula remains raised to the same angle, the right dorsal joints, but not the left ones, will be projected perpendicularly. This contravenes one of the com-



Fig 21 (upper left)
Fig 23 (lower left)

Fig 22 (upper right)
Fig 24 (lower right)

face, gamma rays do influence the glandular secretory elements, which are more radiosensitive than the other structures of the skin, even a single irradiation may

bring about a complete recovery in those cases. Obviously this local therapy is applied after a general medical treatment of the patient (Figs 17-20).

The following description applies to the left apophyseal joint spaces. For demonstration of the left lumbar joint spaces, and is slightly rotated forward so that his right breast remains raised to an angle of 70° , if the patient, in the same general

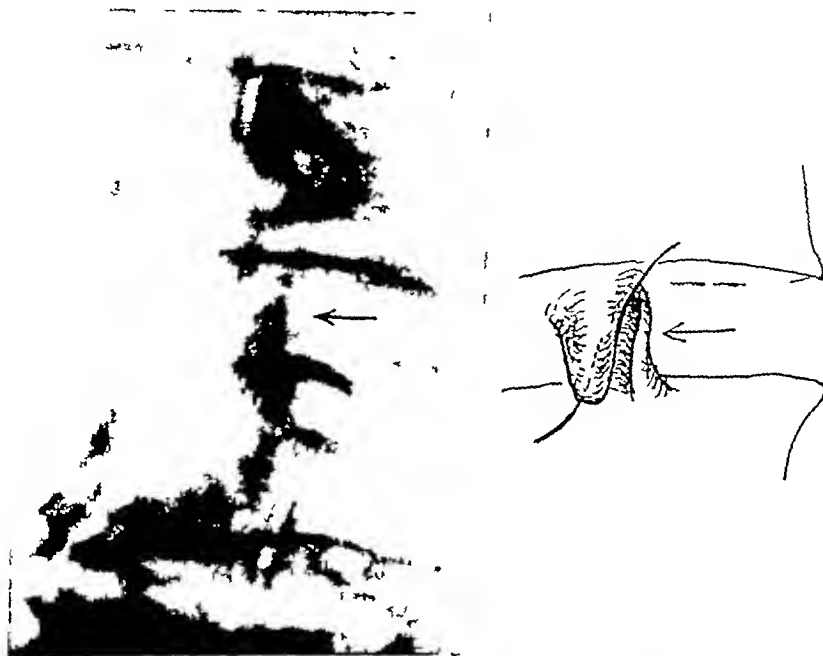


Fig 2 The direction of the facets of the fourth lumbar vertebra (arrow) differs from that of the fifth lumbar in this case. Consequently, the fourth apophyseal joint is overshadowed (false narrowing)



Fig 3 A

Fig 3 B

Fig 3 A flat piece of lead is inserted into a right dorsal apophyseal joint space. In 3 A the left transverse processes are rotated forward the joint space projects perpendicularly (arrow). In 3 B by backward rotation the shadow of the lead projects as a plane (arrow) showing that the joint space does not stand at right angles to the film. This confirms Bakke's objection to Lange's method.

Amount of rotation in either projection 20 degrees

the patient is placed with his back to the film, his left side being in contact with it, and his right side being raised to an angle of 45° . To show the left dorsal joints he is posed with his left side to the film position, is rotated backward so that his right scapula remains raised to the same angle, the right dorsal joints, but not the left ones, will be projected perpendicularly. This contravenes one of the com-



Fig 29 (*upper left*)
Fig 31 (*lower left*)

Fig 30 (*upper right*)
Fig 32 (*lower right*)

tion dose, may be interpreted only as a rejuvenating process taking place in the hair system. In fact, the loss of pigment is generally a symptom of hair senescence.

The study of such cases observed during many years, with special reference to the general reactive organic powers and to the endocrino-sympathetic function, convinced me of the usefulness of employing this type of irradiation in the treatment of alopecia.

In fact, the first case I treated in such a

way four years ago could not possibly present a better result than the one we obtained. It was a form of total alopecia of the scalp and of the eyebrows in a female subject, 21 years of age. The disease had already lasted three years and had resisted every type of local and general treatment (arsenical and phosphoric pluriglandular opotherapy, ultra-violet rays) (See Figs 26 and 27). We irradiated first one-half of the scalp and ob-



Fig 5-A

Fig 5-B

Fig 5-C

Fig 5 Lumbar spine. Figure 5-A is normal. Note that tips of superior (subjacent) articular processes stand exactly opposite to bases of inferior (superjacent). Figure 5-B hypertrophic spondylarthritis. Thinning of the lumbosacral disc (Δ), consecutive displacement of subjacent articular process with marked eburnation and exostoses (white arrows) and obliteration of the included apophyseal joint space. Narrowing of the other apophyseal joints (black arrows) with eburnation and small exostoses (horizontal arrow). Figure 5-C, ankylopoietic spondylarthritis, vertebral bodies greatly rarefied, apophyseal joints ankylosed (white arrow), ligamenta flava ossified (black arrows).

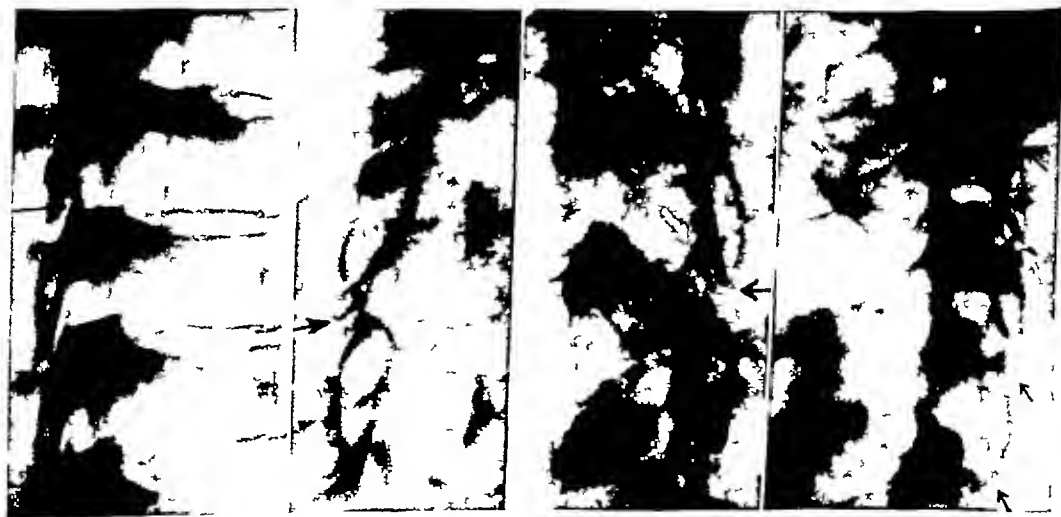


Fig 6-A

Fig 6-B

Fig 6-C

Fig 6-D

Fig 6 Thoracic spine. Figure 6-A is normal. Figure 6-B hypertrophic spondylarthritis, joint spaces narrow, facets ragged, exostotic formations (arrow). Figure 6-C shows chronic atrophic spondylarthritis in one joint (black arrow), joint space narrowed, subjacent articular process rarefied (white arrow), the other joints are normal. Figure 6-D shows ankylopoietic spondylarthritis. One joint space is still faintly visible (white arrow), the others are filled with bony substance (black arrows). Because of the marked generalized rarefaction, the shadows of the ribs appear comparatively dense.



Fig 37 (upper left)
Fig 39 (lower left)

Fig 38 (upper right)
Fig 40 (lower right)

doubtedly an influence on the general conditions of the patient, as evidenced by the return of menstruations. In the first case a determining factor was represented also by secondary radiations of the skin, whereas in the second case this determining factor is to be found in an influence exerted through the endocrino-sympathetic system.

We applied this technic in different

subjects of both sexes, who suffered from total or partial alopecia. In nearly all our cases we observed a new growth of hair which was more or less complete, with only few exceptions. In some cases we assisted to a new falling out of hair after a violent psychical trauma. One must not lose the hope of obtaining a new growth of hair after a second intervention, which must be made when the functions of the

sifications unite, thereby producing bony ankylosis of the articulations affected (ankylopoietic spondylarthritis). The

ossified longitudinal ligaments (Fig 11-B). The ligamenta flava, being involved in the proliferative inflammation of the synovial



Fig 8-A

Fig 8-B

Fig 8. Cervical spine. Ankylopoietic spondylarthritis. 29 months' interval between Figures 8-A and 8-B. Note the increase in bony density after ankylosis has become complete (8-B). Ossified ligamenta flava (arrows).

process may become arrested and remain confined to a section of the spine (Fig 12), or spread to other regions and gradually involve the entire column. As a rule, the rhosacral articulations are simultaneously involved (9) and may become ankylosed (Fig 9), while the costotransversal articulations and the hip and shoulder joints participate less commonly in the arthritic process (21). The vertebral bodies are greatly demineralized in early phases (Figs 9-A, 10, 11-A), but may regain almost normal density after bony ankylosis has become complete (Figs 8, 9, 11-C). The intervertebral spaces remain normal in width, as the discs are not involved, but may appear overshadowed by

membranes, commonly ossify simultaneously with the joints (Figs 5-C, 8-B). Ossification of the longitudinal ligaments is common in advanced stages, but is neither constant nor pathognomonic, being a reaction common to a number of vertebral affections (4, 21). Ossification of these ligaments in the presence of normal intervertebral spaces produces the roentgenologic aspect known as "bamboo spine." Since the ankylosing process usually does not affect all the regions of the spine equally and simultaneously, various phases of the disease may be observed in different sections of the selfsame column.

(2) *Hypertrophic Arthritis*—This condition is determined by a primary lesion



Fig 45



Fig 46

radiobiological study as well as to gamma-ray therapy. As we employ a special cap, gamma rays may be uniformly applied on the surface as well as in depth, notwithstanding the irregularity of the irradiated surface.

Facial hypertrichosis of women, alopecia, and premature baldness are all real illnesses which may have an influence on social life and compromise nervous func-

tions, possibly leading to a real form of phobia. The gamma therapy may bring about noticeable and sometimes even un hoped-for results. This method must be recommended in the interest of such patients, because only by its beneficial influence may they be restored again in such conditions as to perform serenely their duty toward family, society, and toward country.

sifications unite, thereby producing bony ankylosis of the articulations affected (ankylopoietic spondylarthritis). The

ossified longitudinal ligaments (Fig 11-B). The ligamenta flava, being involved in the proliferative inflammation of the synovial



Fig 8-A

Fig 8-B

Fig 8. Cervical spine. Ankylopoietic spondylarthritis. 29 months interval between Figures 8-A and 8-B. Note the increase in bony density after ankylosis has become complete (8-B). Ossified ligamenta flava (arrows).

process may become arrested and remain confined to a section of the spine (Fig 12), or spread to other regions and gradually involve the entire column. As a rule, the iliosacral articulations are simultaneously involved (9) and may become ankylosed (Fig 9), while the costotransversal articulations and the hip and shoulder joints participate less commonly in the arthritic process (21). The vertebral bodies are greatly demineralized in early phases (Figs 9-A, 10, 11-A), but may regain almost normal density after bony ankylosis has become complete (Figs 8, 9, 11-C). The intervertebral spaces remain normal in width, as the discs are not involved, but may appear overshadowed by

membranes, commonly ossify simultaneously with the joints (Figs 5-C, 8-B). Ossification of the longitudinal ligaments is common in advanced stages, but is neither constant nor pathognomonic, being a reaction common to a number of vertebral affections (4, 21). Ossification of these ligaments in the presence of normal intervertebral spaces produces the roentgenologic aspect known as "bamboo spine". Since the ankylosing process usually does not affect all the regions of the spine equally and simultaneously, various phases of the disease may be observed in different sections of the same column.

(2) *Hypertrophic Arthritis*—This condition is determined by a primary lesion

cases of tonsil cancer supplemented by radium and in one by electrosurgery The absolute cure rate is shown in Table II

small square are ten of Coutard's patients, 86 per cent of the cases lie within a zone which in width corresponds to a variation in

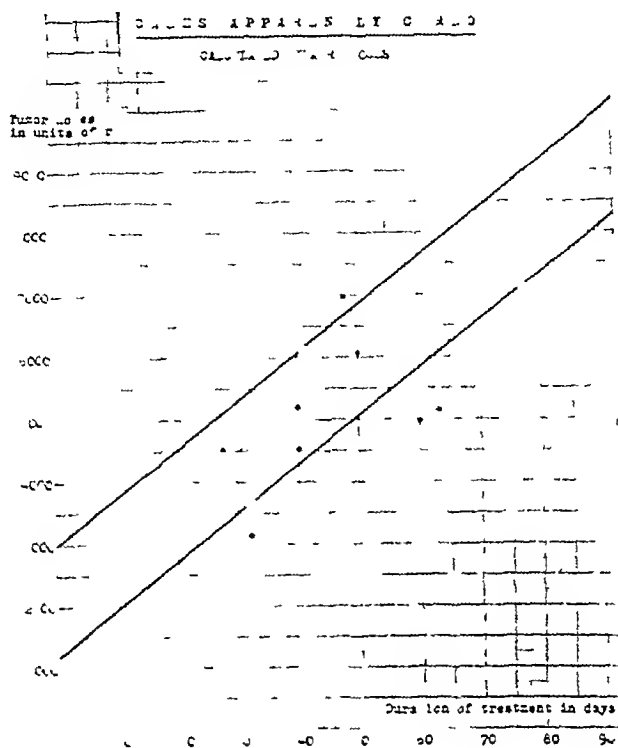


Fig 3

TABLE II —ABSOLUTE CURE RATE

After at least 1 year,	45 of 151	(30 per cent)
2 years,	35 of 121	(29 per cent)
3 years	25 of 88	(28 per cent)
4 years	13 of 53	(25 per cent)
5 years,	6 of 26	(23 per cent)

For details of the treatment I must refer to a paper of mine ² The dosage has been mainly according to clinical criteria, while the physical dose—both daily dose, total dose, and treatment time—has varied considerably

Figure 1 shows the symptom-free cases plotted in a coordinate system, the duration of the treatment (in days) being marked along the abscissa, the total dose on all fields together (back-scattering included) along the ordinate The dots represent our own patients, the crosses, patients from Coutard's reports In the

dose of 3,000 r This zone extends diagonally upward through the field in such a manner that to a longer treatment time there corresponds a larger dose For each additional day of treatment time the dose is increased by about 90 r To a dose of 6,000 r in 20 days corresponds a dose of 6,900 r in 30 days, 7,800 r in 40 days, etc

Figure 2 shows the cases not cured which received over 4,000 r, plotted in the same manner as those in the preceding figure They lie considerably more scattered, only 46 per cent lie in the "favorable" zone, 52 per cent below the inferior borderline A cure has thus been obtained only in exceptional cases with doses of less than 4,900 r in 20 days, 5,800 in 30, 6,700 in 40, 7,600 in 50, or 8,500 r in 60 days At the same time, the 48 per cent of cases not cured which lies above this borderline shows that though a dose of

² Acta Radiologica 1936 17, 209



Fig 11-A

Fig 11-B

Fig 11-C

Fig 11 Lumbar spine three cases of ankylopoietic spondylarthritis at different stages. Figure 11 A rarefaction predominates. Figure 11 B, the ossification of the longitudinal ligaments produces a "bony curtain" (4) behind which the rarefied vertebrae are indistinctly visible. Figure 11-C, ankylosis complete, pain subsided 14 months previously. The vertebral bodies having regained normal density project distinctly through the ossified ligaments.

seems to develop exclusively when by abnormal position of vertebrae the cartilage has been injured by the mechanical stress thus produced. These changes in position may result either from traumatic and destructive lesions of vertebral bodies, or as a consequence of thinning of the intervertebral discs (3, 17, 19, 23). In either case it is usually the articulation below the injured segment which is exposed to increased pressure (17). It is noteworthy that the articular cartilages may resist such persistent stress (21). (See Figs 7-E, 13-A, 16). On the other hand, the bones may not respond by hypertrophy to

a present cartilage lesion. In this case, narrowing of the joint space and displacement of facets (when found associated with one of the static alterations above mentioned) indicate the "hypertrophic" nature of the arthritic process even in the absence of bony hypertrophy (21).

Another type of spondylarthritis, obviously of different origin, is characterized by strongly marked bony hypertrophy of the articular processes, found in the absence of any of the static alterations in question (Figs 7-E, 13, 14-A). Clinical observations suggest a correlation with chronic amebiasis (6, 21, 22).

40 days as values for D_n and n , as that is one of the best determined points, and have from there figured out D_p for various

production of epithelitis on the sound mucosa correspond best with the curve for $R = 10$ or more

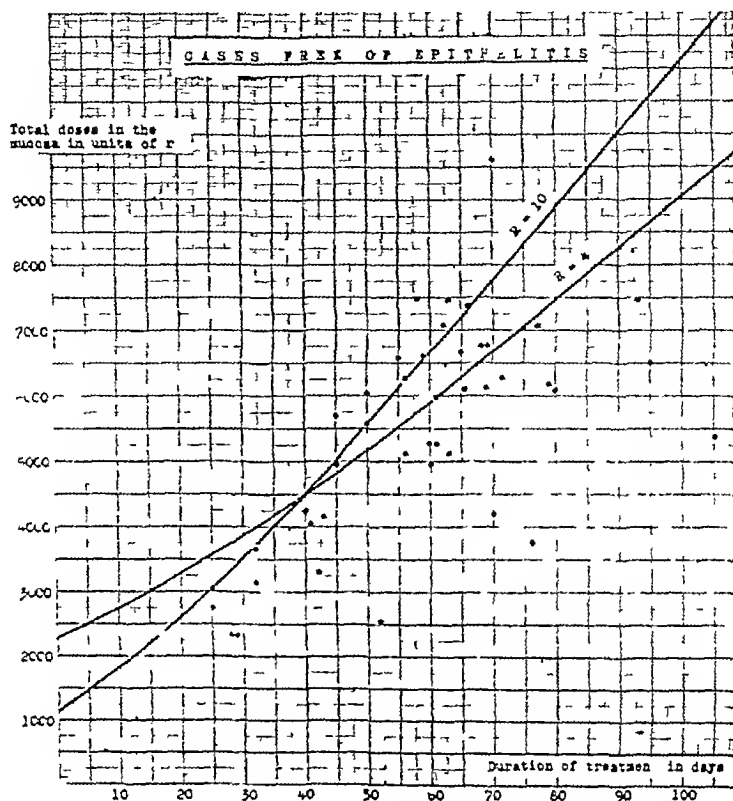


Fig 5

values of p and R . As Figure 4 shows, the curve for the recovery rate equal to 4 per cent is the one whose course corresponds best with the values that were found empirically. The application of the Kingery-Pfahler theory in regard to recovery after ray lesion thus leads to the acceptance of a recovery rate for tumor cells of about 4 per cent per day.

In a similar manner I have plotted (Fig 5) the doses which we in our cases have been able to apply to the sound mucosa without provoking epithelitis. With the use of the same formula, and starting from the dose 4,500 r in 40 days as one of the best determined points of the upper margin, I have constructed the curves for corresponding doses for $R = 4$ and $R = 10$. It will be seen that the threshold values for

Finally, I have in Figure 6 plotted down the empirically found doses which had been applied to the skin of those patients who did not get exudative, but only dry, epithelitis. In calculating the doses, both the back-scattering and the dose through the neck from the other side have been taken into account. In the theoretical calculation of the corresponding doses under different rates of recovery, we have started from the dose of 5,700 r in 40 days. It will be seen that here also a recovery rate of 10 per cent per day is the one which corresponds best with the practical experience.

In Figure 7, I have set down together the three curves determined above, namely, the curves for the upper threshold doses for dry epithelitis, for the upper threshold

in this group of diseases the cartilages remain intact. On the other hand, the static alterations that may result from

(4) *Tumors*—Destruction of articular processes by primary and metastatic tumors occurs occasionally. Erosion by tu-



Fig 14-A



Fig 14-B



Fig 14-C



Fig 14-D

Fig 14 Lumbar spine hypertrophic spondylarthritis. Figure 14-A primary in one joint (arrow) no displacement of facets. Figure 14-B discogenic lesion with obliteration of one intervertebral space (v). Large exostoses (horizontal arrow) facets irregularly indented (arrows). Figure 14-C the lower facets (arrow) are more strongly rotated than the upper ones. Nothing pathological false narrowing. Figure 14-D, joint space narrowed, exostoses at articular processes (arrow).

these diseases may induce secondarily the type of hypertrophic spondylarthritis discussed above under heading 2.

tumors compressing the spine is very rare.

(5) *Fractures*—Isolated fractures of articular processes seem to be more common

tion produces inflammatory changes, especially exudation, in the corium and mucosa. If this exudation becomes so

be observed directly on the skin a sub- or intra-epidermal exudate which disappears as soon as the outer layers of the epidermis

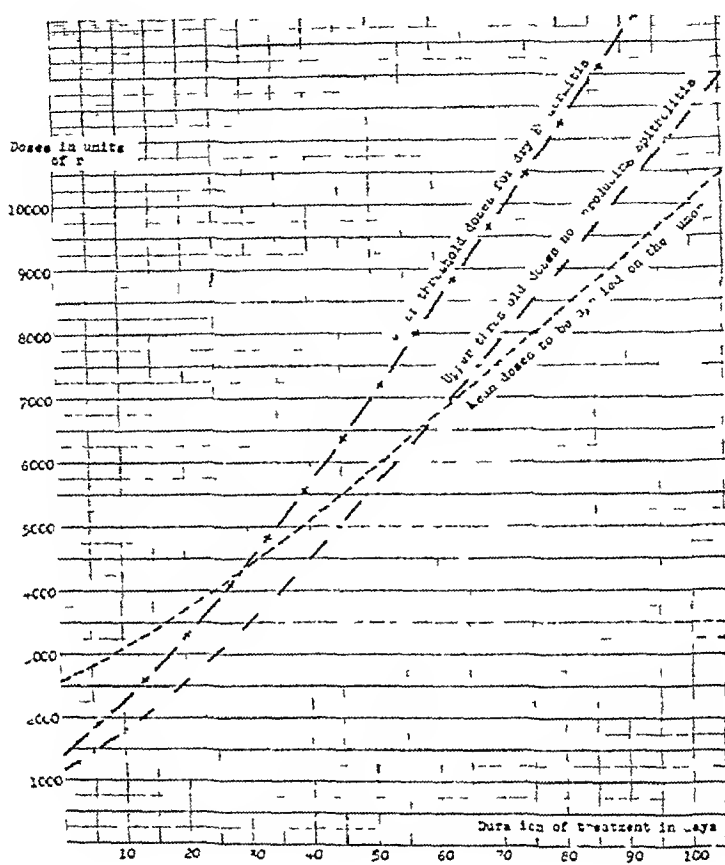


Fig 7

strong that the epithelium is shed, then we get the epithelitis or the exudative epidermitis, if the exudate is resorbed without the epidermis getting completely loosened, then we get the dry epidermitis.

The conception of the vascular and connective tissue changes as the primary is supported by various observations. There are several patho-anatomical parallels to the roentgen reactions in cases in which the epithelial changes are considered as secondary in relation to those in the connective tissue and the vessels. The degree of the reaction to irradiation depends very largely on other factors, which will intensify an inflammation. There may often, just before the reaction culminates,

begin to dry up and get loosened. At the same time, the erythema disappears rather suddenly. Both the epidermitis and the epithelitis can be seen healing up, though the treatment is being continued with the same intensity as before. Finally, there seems to be a distinct parallelism between the degree of the exudative phenomena during the acute reaction, and the degree of the lasting changes, which have their seat in the vessels and connective tissue. The acute epithelial reactions to the irradiation must, therefore, probably be considered rather as secondary results of the direct effect of the irradiation on the vessels and connective tissue than as a direct effect of the rays on the epithelium.

regions that have become more or less strongly immobilized either by a pathological process or by the physiological diminu-

V CONCLUSION AND SUMMARY

The roentgenologic characters of the conditions discussed are classified in Table

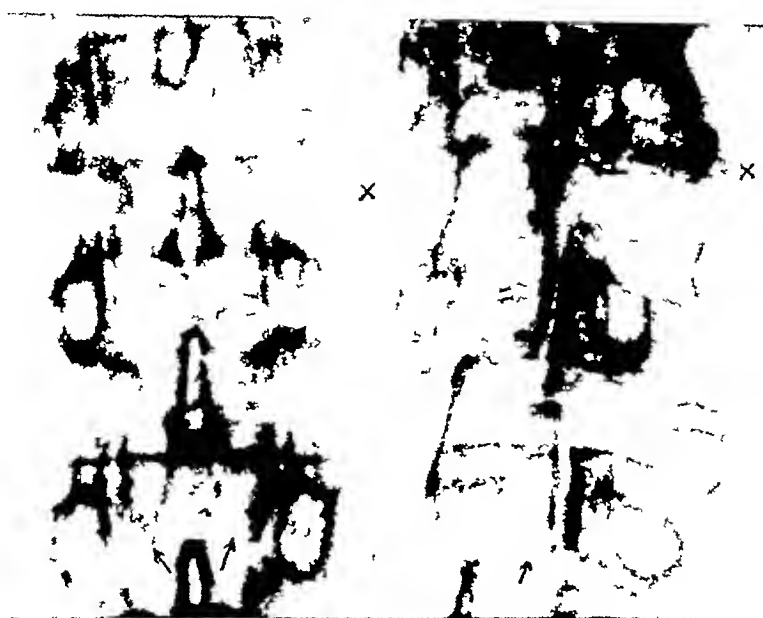


Fig 16-A

Fig 16-B

Fig 16 Lumbar spine typhoid spondylitis with destruction of one intervertebral disc (x) The hypertrophic process has spread to the articular processes (white arrows) without involving the joint spaces The black arrows indicate normal articular processes



Fig 17-A

Fig 17-B

Fig 17 Paget's disease Articular processes involved joint spaces free.

tion of mobility which usually develops in the fifties

I The results would seem to indicate that there is no difference in nature be-

the column—cervical, thoracic, and lumbar. To the median (sagittal) plane of the body, the *cervical* facets stand at right-

angle of very nearly 45° . The respective positions of anode, object, and film are determined of necessity by these anatomi-

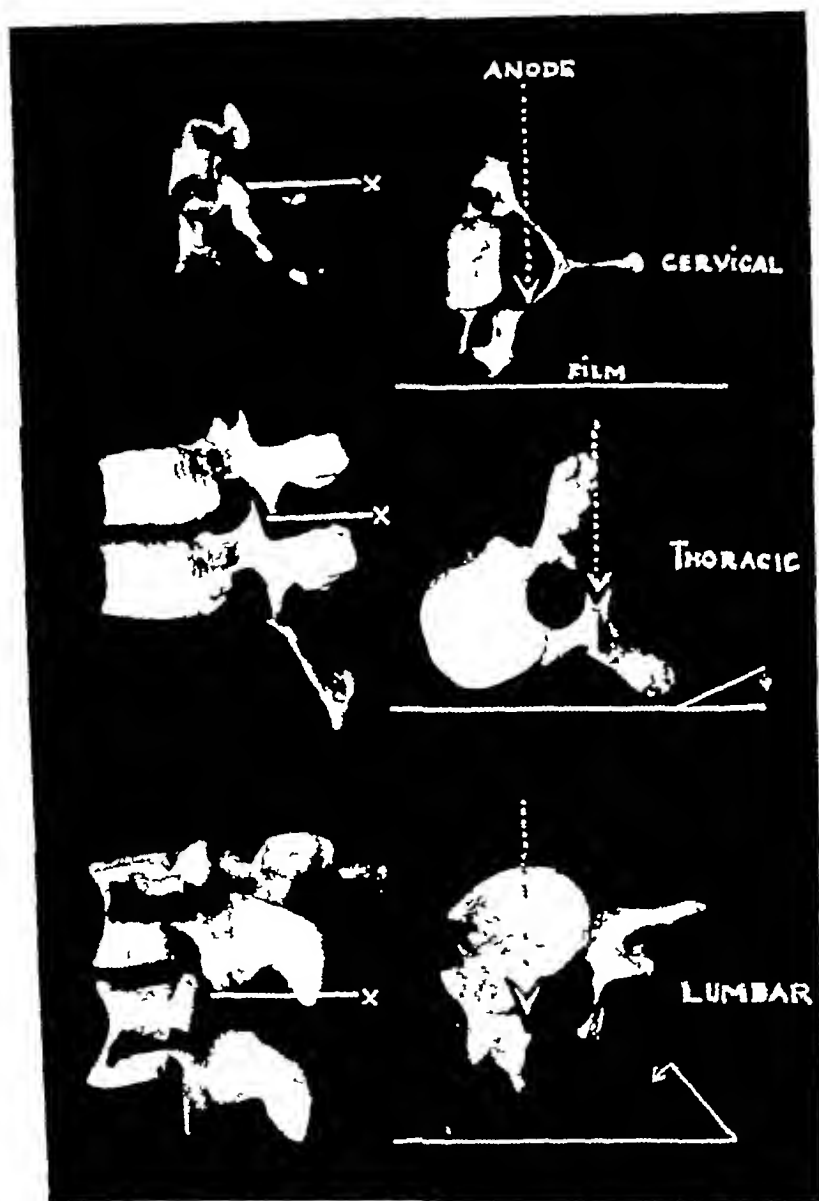


Fig 1 On the left side of the picture pairs of vertebrae are shown in the position in which the left apophyseal joint spaces stand at right angles to the plane of this page. On the right side is shown the amount of rotation that is necessary to obtain this position in the cervical, thoracic, and lumbar regions respectively. The vertical arrow indicates the direction of the central ray.

angles, the *dorsal* facets are slightly rotated forward, forming an angle of about 70° with the said plane, while the *lumbar* facets are strongly rotated backward to an

cal relations (Fig 1), any other position, intermediate or approximate, cannot possibly reveal accurately the details which are essential for consistent interpretation.

tween arthritis localized in the apophyseal joints and arthritis affecting the articulations of the limbs. Calcification of liga-

readiness of the adjacent bone to respond by reactive alterations, and possibly also with the etiology of the disease.

(1) The roentgenographic technic for examination of the apophyseal intervertebral articulations is described.

(2) There are three main types of pathological changes:

(a) atrophic spondylarthritis, acute, chronic, and ankylopoietic,



Fig 18-A



Fig 18-B



Fig 18-C



Fig 18-D

Fig 18 Pott's disease. Figures 18-A and 18-B, vertebral bodies severely affected (x) articular processes normal (arrows). Figures 18-C and 18-D, gradual involvement of the articular processes (11 months interval).

ments may at times mask the similarity. As in other joints, arthritis of various origin and type becomes chronic when the articular cartilage has been involved. This may lead to divers secondary changes varying with mechanical factors, with the

- (b) hypertrophic spondylarthritis, primary, or consecutive upon abnormal mechanical stress,
 - (c) secondary involvement by various affections of the vertebral bodies.
- (3) Affection of the articular cartilage,

mon technics (17, 7), but the simple experiment reproduced in Figure 3 proves that the position above described is correct. To demonstrate the left *cervical* joints, the patient is placed with his left side to the film, the median plane of the body being parallel to the film. The *twelfth thoracic vertebra* has superior articular processes of the dorsal type, rotated forward, but its inferior articular processes are of the lumbar type, rotated backward, hence two different views are necessary to show its joints.

"External landmarks" for centering the x-ray beam should not be used, for the relative position of the vertebræ varies according to size and shape of the chest and abdomen. By palpation of the spinous processes, the position of the articular processes is determined with sufficient accuracy.

The cervical and dorsal facets are very nearly plane, but the lumbar facets and the inferior facets of the *twelfth thoracic vertebra* are cylindrically curved. This curvature produces a summation of normal shadows which may simulate increased bony density, for the same reason as, e.g., a thin layer of fluid in the pleural cavity, seen in the anteroposterior aspect, appears to be either more dense or more readily visible in the lateral than in the anterior and posterior pleural spaces (rule of the tangential projection, Fig 4).

For interpretation of the findings, the following details are important: width of the joint spaces, outlines of the facets, position and bony structure of the articular processes, bony structure in the neighborhood of the articulations, relation of the articular processes to the vertebral bodies and intervertebral spaces, and condition of the ligaments with regard to ossifications.

Normally, the joint spaces are very sharply outlined by the facets, the latter stand parallel, with the tip of the superjacent articular process being exactly opposite to the base of the subjacent (Figs 5-A, 6-A, 7-A). Although the transverse diameter of the articular processes is

much smaller than that of the vertebral bodies, their opacity is equal to or greater, because the compact articular bone casts

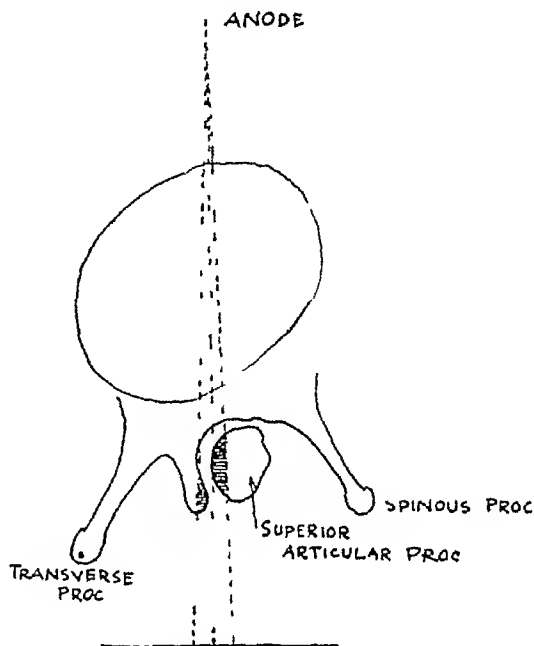


Fig 4 The tangential projection of the curved lumbar facets makes them appear increased in density (see text)

a more dense shadow than the cancellous bone of the vertebral body. The cervical joint spaces, being inclined backward and downward, are diagonal in position, the dorsal almost vertical, and the lumbar vertical, i.e., parallel to the anterior surfaces of the vertebral bodies.

IV PATHOLOGIC CHANGES

(1) *Atrophic Arthritis*—Swelling of the synovial membranes is rarely demonstrable. Only in the cervical spine in cases in which the intervening tissues are thin does this inflammatory thickening occasionally become visible as a foggy, soft shadow obscuring the joint space involved (Fig 7-B). Moderate demineralization, mottled or diffuse, may then be seen in the articular processes. This inflammatory osteoporosis is more pronounced in chronic phases which are characterized by thinning of cartilage producing narrowing of the joint spaces (Figs 6-C, 7-C). The facets remain paral-

OLOGY

- (13) HOHMANN, G, and GÜNTZ E Einseitige entzündliche Knochenveränderungen an einzelnen Gelenkfortsätzen der Lendenwirbelsäule als Ursache schwerer Bewegungstörungen. *Ztschr f Orthop* 1937, 66, 115-130
- (14) HUBENY, M J The Oblique Projection in Examination of the Lumbar Spine. *RADIOLOGY* May, 1931, 16, 720-724
- (15) JORDAN, H Roentgen Analysis of the Spine with Description of Some New Technical Instruments *RADIOLOGY*, June 1937, 28, 714-724
- (16) KNAGGS, R L Spondylitis deformans *British Jour Surg*, January, 1925 12, 524-546
- (17) LANGE, M Die Wirbelgelenke Second edition F Enke, Stuttgart 1936
- (18) LÉRI, A Spondylose Rhizomélique. Handbuch der Neurologie, II, 500 Herausgegeben von O Lewandowski J Springer, Berlin, 1911
- (19) OPPENHEIMER, A Diseases Affecting the Intervertebral Foramina *RADIOLOGY*, May, 1937, 28, 582-592
- (20) OPPENHEIMER, A, and TURNER, E L Discogenetic Disease of the Cervical Spine with Segmental Neuritis *Am Jour Roentgenol and Rad Ther* April, 1937, 37, 484-493
- (21) OPPENHEIMER, A Diseases of the Apophyseal (Intervertebral) Articulations *Jour Bone and Joint Surg*, April 1938, 20, 285-314
- (22) PEMBERTON R Arthritis and Rheumatoid Conditions Their Nature and Treatment Lea & Febiger Philadelphia, 1930
- (23) SCHMORL, G Archiv und Atlas der normalen und pathologischen Anatomie in typischen Röntgenbildern Die gesunde und kranke Wirbelsäule im Röntgenbild Pathologisch anatomische Untersuchungen. Für die Röntgenkunde bearbeitet von Herbert Junghanns Fortschr a d Geb d Röntgenstrahlen Ergänzungsband XLIII G Thieme, Leipzig, 1932
- (24) SIMMONDS, M Ueber Spondylitis deformans und ankylosierende Spondylitis Fortschr a d Geb d Röntgenstrahlen, 1903 7, 51-62
- (25) SIVÉN V O Zur Kenntnis der sogenannten chronisch ankylosierenden Entzündung der Wirbelsäule. *Zeitschr f klin Med*, 1903, 49, 343

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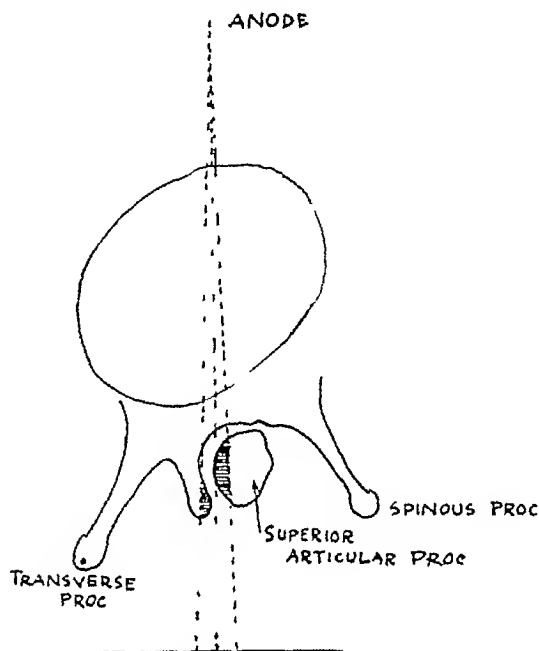


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REFERENCES

- (1) BAKKE, S N Spondylosis ossificans ligamentosa localisata. Fortschr a d Geb d Röntgenstrahlen, March, 1936, 53, 411-417
 - (2) BENEKE, R Zur Lehre von der Spondylitis deformans Beiträge zur wissenschaftlichen Medizin, Festschrift dargeboten den medicinischen Theilnehmern an der LXIX Versammlung Deutscher Naturforscher und Aerzte vom Herzoglich Braunschweigischen Staatsministerium Herausgegeben von R Beneke H Bruhn, Braunschweig 1897, p 109
 - (3) CALVÉ, J, and GALLAND, M The Intervertebral Nucleus pulposus, Its Anatomy, its Physiology, its Pathology Jour Bone and Joint Surg July, 1930, 29, 555-578
 - (4) CHAUMET, G Traité de Radiodiagnostic Vol I (Squelette), p 181 Vigot Frères Paris, 1930
 - (5) DITTMAR, H Weitere Mitteilungen über Schrägaufnahmen an Knochen und Gelenken Röntgenpraxis, 1930, 2, 1022-1027
 - (6) ELY, L W The Great Second Type of Chronic Arthritis California St Jour Med, October, 1922 20, 329-331
 - (7) FRAENKEL EUGEN Ueber chronisch ankylosierende Wirbelsäulenversteifung Fortschr a. d Geb d Röntgenstrahlen, 1903, 7, 62-90
 - (8) GHORMLEY, R K., and KIRKLIN B R The Oblique View for Demonstration of the Articular Facets in Lumbosacral Backache and Sciatic Pain Am Jour Roentgenol. and Rad Ther, February, 1934, 31, 173-176
 - (9) GOLDING, F C Spondylitis ankylopoietica British Jour Surg, January, 1936, 23, 484-500
 - (10) GÜNTZ, E Beiträge zur pathologischen Anatomie der Spondylarthrits ankylopoietica Fortschr a d. Geb d Röntgenstrahlen June, 1933, 47, 683-693
 - (11) HADLEY, L A Subluxation of the Apophyseal Articulations with Bony Impingement as a Cause of Back Pain Am Jour Roentgenol and Rad Ther, February 1935, 33, 209-213
 - (12) HENCH P S, BAUER W FLETCHER, A A, CHRIST D, HALL, F, and WHITE, T P The Problem of Rheumatism and Arthritis Review of American and English Literature for 1935 (Thurd Rheumatism Review) Ann Int Med, December, 1936 10, 754-909
-



Fig 7-A



Fig 7-B



Fig 7-C



Fig 7-D



Fig 7-E



Fig 7-F

Fig 7 Cervical spine Figure 7-A normal Figure 7-B, acute spondylarthritis One joint space obscured (arrow), the subjacent articular process shows slight mottled rarefaction. Figure 7-C chronic atrophic arthritis One joint space narrowed (arrow) the adjacent articular processes rarefied and thinned Figure 7-D ankylopoietic spondylarthritis Same patient as shown in Figure 6-D Two joint spaces narrowed (arrows), longitudinal ligaments ossified (v) Figure 7-E, hypertrophic spondylarthritis One pair of articular processes greatly increased in density (arrow), the joint between them ankylosed Intervertebral disc at this level normal Below two discs are thinned (v) but the corresponding joints are normal Figure 7-F, spondylosis ossificans ligamentosa Joints normal, discs normal Deformity at the anterior margins of the vertebral bodies due to apposition of calcified ligaments

lel, but are less clearly outlined than in adjacent normal joints (Fig 6-C), hence the margins of the joint space appear indistinct or blurred The intervertebral discs are not involved (Figs 7-B, 7-C)

Under certain conditions (9, 17, 18) the disease may become systemic a variable

number of apophyseal joint spaces become narrowed, and the outlines of the facets may appear irregularly scalloped (Fig 10-B) After an interval of at least twelve months, new bone forms on contiguous facets and gradually grows into the joint spaces (Fig 6-D) Eventually these os-

2 e, ribs, 10 per cent, vertebræ or clavicle, 8 per cent in each, skull or femur, 4 per cent, in each, pelvis or sternum, 2 per cent in each. Only three of our cases showed brain or skull metastasis, a frequency much lower than that of Fried's and probably due to the fact that the brain was not routinely studied in our autopsy material.

One of the most striking features encountered was the number of cases in which the metastatic foci from the primary lesion so overshadowed or dominated the clinical picture as to produce in a fair minority of 11 cases no pulmonary symptoms at the time of admission here. These cases are herein referred to as those of atypical onset in contradistinction to the great majority with the usual pulmonary onset, or those which in the course of such pulmonary symptoms later develop additional signs and complaints due to extra pulmonary metastasis which are most difficult of recognition except by the acquirement of that eternal vigilance which becomes the outgrowth of the development of a bronchus carcinoma consciousness.

HISTOPATHOLOGY

We have assumed the unitary cellular origin from the basal cell deposits in the lowest mucosal layer of the bronchial tree as the basis for the observations which follow, especially for the marked pleomorphism displayed in these sections. In some specimens this phenomenon was so marked as to make it difficult to determine a predominating cellular arrangement or tendency. Generally, it was possible, however, to classify arbitrarily this material into groups depending on the predominating cellular arrangements or patterns, as

shown in Table IV. Here we have assumed the adenocarcinoma to be the most differentiated group and, therefore, have

TABLE IV—HISTOPATHOLOGIC CLASSIFICATION

(According to predominating cellular tendency)¹

	Cell Differentiation	No Cases
Adeno-carcinoma	I Adenocarcinoma tendencies	
	(a) Non mucus producing with columnar cells lining acini	4
	(b) Mucus producing	2
	(c) With cuboidal cells lining acini	0
Squamous-cell lesions	II Squamous-cell tendencies	
	(a) Keratinizing (pearls)	22
	(b) Non keratinizing	12
	III Basal-cell tendencies (transitional)	6
Anaplastic	IV Round-cell tendencies (medullary)	14
	V Spindle cell tendencies (oat cell)	2
		<hr/> 82
	Cell Undifferentiation	

¹ Based on the assumption of the unitary cellular theory of origin from the basal cell deposits beneath the bronchial mucosa as postulated by Fried.

placed these at the upper end of the table, followed by the squamous-cell group in the middle and the undifferentiated or anaplastic growths at the end. It is interesting to note that in such a classification the majority of the cases seen by us fell into the squamous-cell variety. We appreciate, however, that such percentage figures are of little significance and tend necessarily to vary in any such small series. We were unable to note any marked difference in respect to the average survival periods or metastatic propensities of the various types. These points will,

TABLE V—CARCINOMA BRONCHUS

Predominating Tumor Tendencies	Second	Third	Decades in Which Tumor Appeared	Fourth	Fifth	Sixth	Seventh	Totals	
I _a } Adeno-carcinomatous		1	1	2	1	1		4	
I _b }				1				2	
I _c }								0	
II _a } Differentiated	2		5	13	2	2		22	
II _b } Squamous Cell		2	3	2	4	1	1	12	
III				5	1			6	
IV } Anaplastic	4	3	1	4	2			14	
V } Squamous Cell			1				1	2	
All Groups	6	6	11	27	10	2	2	82	Available for grouping



Fig 9 A



Fig 9 B

Fig 9 Sacro-iliac articulations of the patient referred to in Figure 8, there was a 29 month-interval between 9 A and 9 B. Bony density increased after ankylosis became complete (9 B)

joint and at the adjacent surfaces. Only the alterations in the bones are visible roentgenologically. Hypertrophic changes may also develop in the course of some low-grade infection that is primarily associated with rarefaction, in which case the findings may overlap.

The narrowing of the joint space and the irregular outlines of the facets are similar in atrophic and hypertrophic spondylarthritides, but in the latter, the articular processes are increased in density. Small exostoses often form at the tips of the articular processes and at the facets, and bulge into the joint spaces (Figs 5-B, 13, 14-A, 14-B). In other cases, these hypertrophic reactions are less conspicuous, and it may then become difficult to distinguish this type from atrophic spondylarthritides. The absence of rarefaction is in favor of the hypertrophic form, but it is especially the position of the articular processes which is of significance. As mentioned above, the facets remain parallel in atrophic spondylarthritides, whereas in the type of hypertrophic spondyl-



Fig 10-A



Fig 10-B

Fig 10 Lumbar spine ankylopoietic spondylarthritides involving the sacro-iliac joints (10 A). Because of the generalized rarefaction the column appears almost translucent. The arrows in 10 B point to the ankylosed joints. No calcification of ligaments. Anteroposterior and lateral projections would not reveal the significant findings in these cases.

of the cartilage inducing hypertrophic reactions of the various tissues within the arthritides now discussed, they are either displaced or convergent, for this form

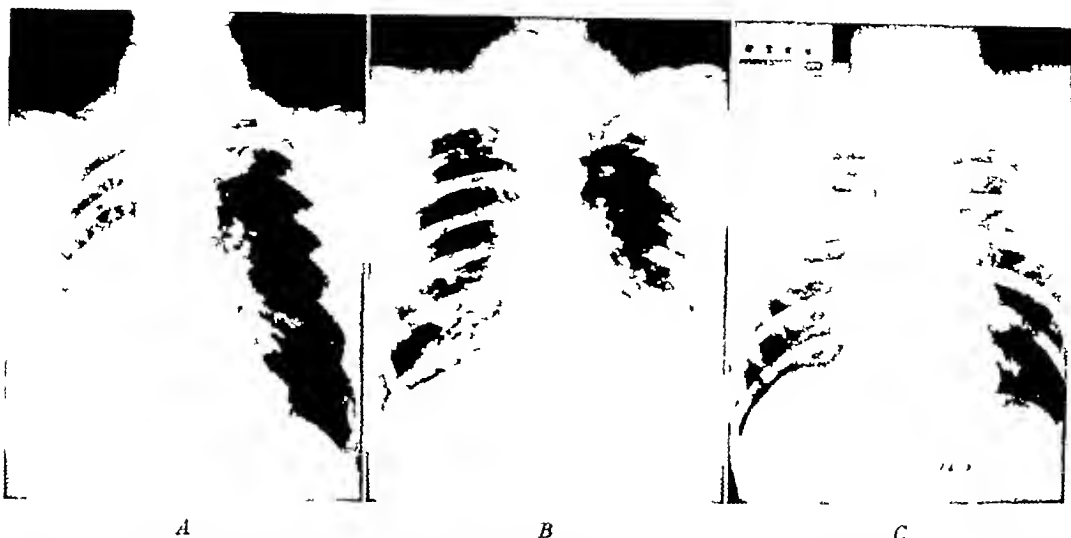


Fig 2 Chest radiographs of the three clinical types described above (A) Central or hilus type, the most common. Incidentally note concomitant metastatic bone lesion in the left clavicle. (B) The parenchymatous or peripheral type representing 11 per cent of our cases. (C) The type with non pulmonary onset. Here in this particular case, metastatic involvement of inguinal nodes first caused the patient to seek medical advice.

the possibility of bronchus carcinoma. By such routine, marked discrepancies between the roentgen findings and those obtained on ordinary physical examination often become all too apparent. Whenever the roentgen studies suggest the possibility of lung tumor, the case should be further investigated by bronchoscopy, thoroscopy, or a cellular study should be made of any chest effusion in the hopes of confirming suspicions from such biopsy materials.

Whereas the x-ray is not absolutely conclusive, nevertheless, it takes one of the most prominent parts in diagnosis on account of its easy facility in most cases, its usual superiority over ordinary physical examination, and the usual indirect signs observed which often suggest the necessity for bronchoscopy. The writer believes that the apparent frequency of bronchus carcinoma may be attributed mainly to the more frequent and systematic use of both the x-ray and bronchoscope rather than an actual increased incidence of this disease.

Under roentgenographic management of such cases we recommend a routine procedure of study using lipiodol, Potter-Bucky films, and artificial pneumothorax, if necessary, in addition to the usual postero-anterior and lateral chest films. We have

found a single postero-anterior and a lateral film preferable in our experience to the routine stereoscopic postero-anterior pair, as we feel that more information can be gained from these two projections than is usually obtained from the stereo set alone.

Under roentgen findings it should be noted that a unilateral density, in contradistinction to the bilateral shadows as in tuberculosis, found in an individual past 30 should always obligate the examiner to rule out bronchus carcinoma.

These chest shadows may assume various characteristics commonly spoken of as being due to atelectasis, tumor mass, increased markings, abscess, effusion, etc. From a study of the x-ray films in our cases it would appear that increased markings may be one of the earliest signs. Atelectasis, on the other hand, is the most common early roentgen finding in the centrally located tumor, whereas tumor mass is the most common early finding in the peripherally located growth. Signs of abscess formation should be critically scrutinized as, according to Edwards, 10 per cent were later proven to be peripherally located lung cancer in the process of necrosis.

A classification of our findings in accord-

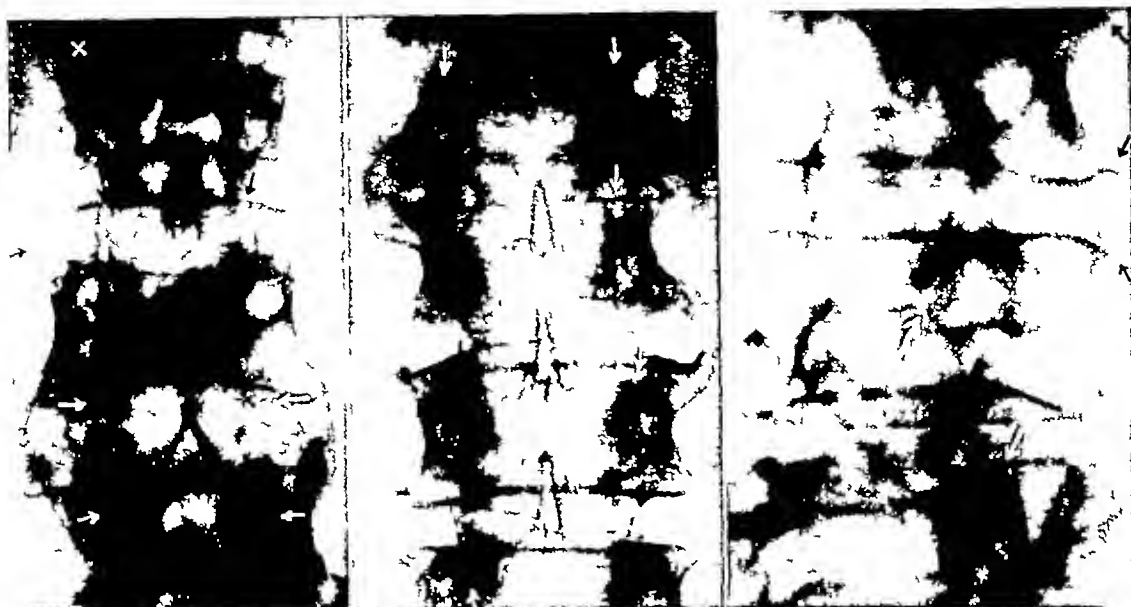


Fig 12-A

Fig 12-B

Fig 12-C

Fig 12 Lumbar spine, arrested ankylopoietic spondylarthritis. Excepting for stiffness the clinical symptoms subsided seven and eleven years before, respectively. The black arrows point to joint spaces that are still normal or almost normal, the white arrows, to narrowed or ankylosed joints. In 12-C, the black arrows indicate partial ossification of the anterior longitudinal ligaments.

Exostoses at contiguous facets may fuse (23), there results ankylosis of the apophyseal joint (Fig 13-B). By the increased density of the articular processes, this ankylosis is distinguishable from ankylopoietic spondylarthritis.

The complicated interrelations between thinning of the intervertebral discs, hypertrophic spondylitis, and hypertrophic spondylarthritis are discussed in the clinical report.

(3) *Secondary Involvement*—Both rarefying and hypertrophic osteitis may spread from vertebral bodies to the articular processes, though this is not very common. It would seem that the distant position of the articular processes as well as the greater resistance of their compact bone prevents the articulations from being easily affected. For example, in tuberculous spondylitis the articular processes have been found involved in only 19 per cent of our cases, the disease is often arrested before the articular processes are reached by the infection (Fig 13-A). In osteoperiostitis (13), hypertrophic osteitis

(Fig 16), and Paget's disease (Fig 17) the articular processes may participate in the vertebral affection, but the joint spaces often remain normal in width, and the outlines of the facets remain smooth. This corresponds to clinical and histological (13) findings which seem to indicate that

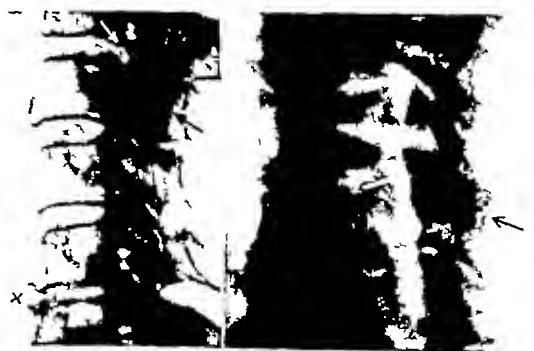


Fig 13-A

Fig 13-B

Fig 13 Cervical spine hypertrophic spondylarthritis. Ankylosis (black arrows) by fusion of exostoses (white arrows). Narrowed intervertebral space at (Δ), the apophyseal joint at this level is normal (see text).

cases in a radiologic series are generally the more advanced centrally located lesions which by their nature are quite unsuitable for any therapy, but as a last resort are generally consigned to the radiologist. In spite of this, however, a marked palliation and freedom from distressing symptoms after irradiation may be immediately expected in many. In a few, we feel that the irradiation has hastened necrotic processes in tumor and adjoining lung tissue with resulting early death by pulmonary hemorrhages. Whereas the average survival is slightly longer after therapy, *i.e.*, six months as shown in our cases as against 4.5 months in the untreated, we do not consider this difference as significant. Incidentally, it may be of interest to mention that in the series both cases operated upon showed marked squamous-cell characteristics, which group Vinson has suggested as probably most suited for radical chest surgery.

The longest survivals in this series were 18 months in one case and 12 months in two others. The average survival in seven cases that lived over eight months after treatment was 12.6 months.

From the above, therefore, it will be seen that radiologic results of treatment of these tumors, at least in our hands, has been chiefly palliative and far from encouraging. On the other hand, the marked pleomorphism even bordering onto anaplasia of these lesions, their inherent tendency to distant and early metastasis, and the greater preponderance of the less favorable hilar types should make these lesions more unsatisfactory for surgical procedures. Under the encouragement of frequent favorable radiologic response of the somewhat histologically comparable squamous-cell lesions of the tonsil, pharynx, and larynx, we are, therefore, inclined to advise redoubling effort and acumen in order to achieve earlier and better diagnosis and therapy, particularly for those patients who still will be reticent in submitting to as yet a possibly lethal exploratory thoracotomy in order to confirm the suspicious existence or questionable operability of a primary pulmonary malignancy.

SUMMARY

1 A review of 73 cases of bronchus carcinoma seen at the State Institute has been made, and of these cases 65 were proven by histopathologic section on biopsy or autopsy, or both.

2 Histopathologic studies of the available material in 62 cases revealed a marked pleomorphism in most, with a tendency to predominating cell types or groups, depending on the degree of differentiation, into adenocarcinomatous, squamous-cell, and anaplastic tendencies.

3 A grouping of roentgenographic characteristics showed atelectasis, increased markings, and tumor mass to be the three most frequent findings in the order mentioned. Atelectasis is a common indirect finding in the hilar or central variety and the direct visualization of the tumor mass is commonly seen in the peripheral tumors. No apparent association could be observed between the histologic type and the period of survival which in the treated cases was only slightly longer than in the untreated.

4 Neither radical surgery nor irradiation therapy seems at present to warrant much optimism in the majority of these cases. On account of the tendency to early and distant metastasis and the more advanced and unfavorable locations of the tumors seen by us, it seems advisable for us to persist in attempts at more intensive and better planned radiation therapy. We see few peripheral lesions and fewer patients who will submit to radical thoracic surgery.

5 Earlier recognition and therapy still remain the urgent cry, if better prognosis is to be expected.

BIBLIOGRAPHY

- EDWARDS A. T. Malignant Disease of the Young. *Jour Thoracic Surg* December 1934 4, 107-124.
 EHRLICH D. E. and HAUPTMAN H. A. Primary Carcinoma of the Lung. *RADIOLOGY* May 1936 26, 563-573.
 FARRELL JOHN T. JR. Diagnosis of Bronchial Carcinoma. A Clinical and Roentgenologic Study of 50 Cases. *RADIOLOGY* March 1936 26, 261-269.
 FRIED B. M. Primary Carcinoma of the Lung. *Medicine* December 1931 10, 373-508.
 GANTENBERG R. Erfahrungen über Klinik und Behandlung intrathorakaler Tumoren. *Strahlentherapie* 1933 47, 426-442.



Fig 15-A

Fig 15-B

Fig 15-C

Fig 15 Lumbar spine, discogenetic 'hypertrophic' spondylarthrititis Three intervertebral spaces narrowed (x) Articular processes displaced joint spaces narrowed, eburnation of facets No hypertrophic reactions at the vertebral bodies

in the cervical spine than in other sections. They are usually associated with compression fractures of adjacent vertebral bodies or with traumatic destruction of intervertebral discs. Callus formations are usually absent, even a number of years after the injury (Fig 20).

(6) *Malformations*—Congenital absence of articular processes is usually associated with other congenital malformations of a number of vertebrae (Fig 21). Variations in size and shape are common in the lumbar region. Persistent epiphyses at the tips of lumbar articular processes may become displaced by trauma (Fig 21).

(7) *Isolated Rarefaction of Articular Processes*—This condition in which one articular process shows irregular rarefaction (19) is of interest merely because of its being invariably associated with severe radiculitis. The joint spaces remain normal (Fig 19).

(8) *Spondylosis Ossificans Ligamentosa*—This condition has no direct relation to spondylarthrititis. It is marked by exten-

sive calcification of ligaments, there are no other changes. Neither the vertebral bodies, the discs, nor the articulations are involved (Fig 7-F). The thoracic spine is more commonly affected than other sections. In a particular form, only the ligamenta flava calcify (1). This type of ossification differs from that found in spondylarthrititis ankylopoietica by the absence of changes in the apophyseal joints, but the distinction is not always easy, for the ossified ligaments may completely overshadow the joint spaces.

On the other hand, calcification of ligaments is quite commonly associated with various vertebral lesions, e.g., spondylarthrititis ankylopoietica, hypertrophic spondylitis, Pott's disease, and traumatic lesions. But it is characteristic of the form above described that it is independent of such changes, wherefore it would seem preferable to distinguish it from the ligamentous calcification associated with other spinal lesions. It seems as though the ligaments may calcify or ossify in

THE EFFECT OF FRACTIONAL ROENTGEN TECHNIC ON THE INCIDENCE OF VAGINAL FISTULÆ IN CARCINOMA OF THE CERVIX¹

By FRANK RAYMOND SMITH, M D , F A C S , *New York City*

IN 1934 the writer published a report (1) of vaginal fistula incidence based upon the study of 2,852 case records of patients having carcinoma of the cervix. It has been stated (2) that the incidence found was too low, and it is true that it is lower than the incidence found by Graves (2) and his co-workers in treated cases, it is also true that the untreated cases in this study did have a lower fistula incidence than the untreated series reported by Behney (3) and Williams (4). This criticism of the actual figures is undoubtedly just, for all the patients whose records were included in this study were not autopsied, and only by autopsy could the minute, non-symptomatic fistulæ be detected. However, the general principle presented (that the incidence of vaginal fistula is higher in untreated than in irradiated cases, hence principally a manifestation of the progress of the disease rather than of injury by irradiation) still holds true and has been substantiated by these very critics of my actual figures, and by others (3).

Because the method of therapy was found to influence fistula incidence somewhat and because of the increasing popularity of divided dose x-ray technic, it seems reasonable to study patients treated for carcinoma of the cervix during this last four-year period while the use of divided roentgen dosage has progressively increased.

Table I shows the comparison of fistula incidence as previously reported (1) to be more than twice as frequent in untreated as in treated patients. All of these patients were treated by massive dose roentgen therapy.

¹ The patients used in this study were from the Gynecological Service of William P. Healy, M.D., at Memorial Hospital.

TABLE I—INCIDENCE OF VAGINAL FISTULÆ IN IRRADIATED AND IN UNTREATED PATIENTS (1916 TO 1932)

Classification	Case	Fistulæ	Per centage
Irradiated and Living	575	12	2.0
Irradiated and Dead	2,277	82	3.6
Irradiated Total	2,852	94	3.2
Untreated Patients	96	7	7.2

Table II shows by the yearly incidence of fistulæ from 1933 to 1936, inclusive,

TABLE II—COMPARISON OF YEARLY FISTULA INCIDENCE IN PRIMARY CERVIX CARCINOMA TREATED BY X-RAY AND RADIUM AS TO STAGE OF DISEASE

Year	Early			Advanced			Total		
	No	Fis-tula	Per-cent-age	No	Fis-tula	Per-cent-age	No	Fis-tula	Per-cent-age
1933	11	1	9.1	106	8	7.6	117	9	7.6
1934	11	0	0	118	2	1.7	129	2	1.5
1935	15	1	6.7	104	6	5.8	119	7	5.9
1936	16	0	0	118	3	2.5	134	3	2.2
Total	53	2	3.8	446	19	4.3	499	21	4.2

that the patients with advanced disease had a somewhat higher incidence than those treated in the early stage. Also, the total incidence (4.2 per cent) is only slightly higher than the previously reported incidence (3.2 per cent) in a much larger series of patients. This table does not differentiate as to whether patients were treated by massive or by divided dose roentgen therapy.

TABLE III—COMPARISON OF YEARLY FISTULA INCIDENCE AS TO METHOD OF X-RAY THERAPY USED

Divided Dosage					Massive Dosage		
Treatment	Year	No	Fis tula	Per cent age	No	Fis tula	Per cent age
X ray and Radium	1933	48	2	4.1	69	7	10.0
	1934	45	2	4.4	84	0	0
	1935	45	3	6.6	74	4	5.3
	1936	75	2	2.6	59	1	1.6
	Total	213	9	4.4	286	12	4.1
X ray only	1933-1936	10	0	0	20	0	0
	Total	223	9	4.0	306	12	3.9

TABLE I—CLASSIFICATION ACCORDING TO ROENTGENOLOGIC ASPECT

Disease	Synonyms	Etiology	Anatomical Characters	Apophyseal Joint Space	Position of Facets	Capsule	Ligaments	Articular Processes	No ob- serva- tions
(1) Spondylarthritis (a) Acute		Infectious	Inflammation of synovial membranes (osteoporosis ¹)	Obscured	Parallel	Thickened	Not visible	Normal or slightly rarefied	7
(b) Chronic atrophic		Infectious	Inflammation of synovial membranes inflammatory osteoporosis thinning of articular cartilage	Narrowed	Parallel	Not visible	Not visible	Moderately rarefied thinned	4
(c) Ankylo- poietic	Spondylose rhizomélique Bechterew's disease Strümpell Marie's disease Arthritis of spine Syndesmotic spondylitis Spondylitis ossificans ligamentosa	Infectious endogenous factors	Proliferative inflammation of synovial membranes destruction of cartilage pronounced osteoporosis fibrous followed by bony ankylosis of facets ossification of ligaments flava (and longitudinal)	Narrowed or obliterated later bony ankylosis	Parallel	Not visible	Provo ossified longitudinal ossification of ossification stages	Greatly demineralized may regain normal density after ankylosis has become complete	11
(d) Hyper trophic	Spondylarthrosis Trophostatic osteoarthrosis Osteo-arthritis of spine ¹	Either infectious or due to static changes	Ulceration of cartilage eburnation of articular surfaces villous hypertrophy of synovial membrane, exostoses ossification of intra articular ligament	Irregularly narrowed	Often Convergent	Not visible	Ossification to constant	Eburnation of facets exostoses at articular processes	89
(2) Spondylitis (a) Tuberculous			Involvement of articular processes inconstant					Rarefied or destroyed when involved	14
(b) Hyper trophic	Spondylosis deformans Spondylitis deformans Osteo-arthritis of spine ¹	Low grade infection and consecutive upon thinning of discs	Eburnation and exostoses of vertebral bodies calcification of longitudinal ligament subluxation of articular processes secondary hypertrophic spondylarthritis (inconstant)	Irregular narrowing ¹	Convergent	Not visible	Usually ossified ¹	Eburnation of facets exostoses at articular processes ¹	(72)
(3) Spondylosis ossificans ligamentosa	Spondylitis deformans ¹	Usually degenerative active	Calcification of ligaments	Normal	Normal	Not visible	Calcified	Normal Other conditions observed	(18) 22 147

¹ These terms are variously used and do not define anatomical entities
² These changes are not typical of spondylitis but of the secondary involvement of the apophyseal joints

DIRECT RADIOCINEMATOGRAPHY¹

By DR VAN DE MAELE, *Brussels, Belgium*

ALTHOUGH the progress in radiologic apparatus and technic has been rapid and considerable, we must admit that there is still a great difference between the living organism and a mere roentgenogram. This is so because instantaneous roentgenography fixes the appearance of the living organs only during a fraction of a second of their period of movement. Since Roentgen's discovery, radiologists have endeavored to fix on the film the movement of the organs, but during these many years their efforts have failed for various reasons. Some of these may be listed as follows: lack of power and regular output of the high tension generators, fragility and insufficient electrical charge of the tubes, the low sensitiveness of roentgen-photographic plates, the difficulty in handling them (glass plates), and the limited illumination of fluorescent and intensifying screens. During the last few years, as a result of the great progress made in the construction of roentgenologic material, roentgen cinematography has become a reality and definitely has taken its place in roentgen diagnostic technic.

Until recently considered as a slightly fantastic and not very practical investigation, roentgen cinematography has now asserted itself as a procedure within the reach of every one, the results of which, in the study of the normal and pathologic morphology of moving organs, give us new hope and appear to have an importance as yet unsuspected.

I METHODS OF ROENTGEN CINEMATOGRAPHY

If we consider the roentgen cinematographic processes at present in vogue, we find on the one hand, the roentgenoscopic method, which consists in filming the roentgenologic images which are projected

in succession upon a fluorescent screen, on the other hand, the roentgenographic method which registers directly on a reel or a series of roentgenographic films a considerable number of ordinary roentgenograms, which are later transferred upon standard projection film.

(A) *Roentgenoscopic Roentgen Cinematography*—This procedure belongs to the group classed under indirect roentgen cinematography, so-called because X energy is transformed into a form of energy that is easier to register.

The very short wave length of the roentgen beam is transformed into the longer wave length belonging to the luminous octave.

The principle of the method is as follows: with the aid of a powerful high tension generator having a constant debit, we illuminate a fluorescent screen as intensely as possible, and with a special motion picture apparatus, placed at a distance of from 1.5 to 2 m, we reproduce upon an extremely sensitive cinematographic film of small size, the images which are projected on the screen.

In order to catch these silhouettes at a rate of at least 16 films per second, the camera must be equipped with a very luminous objective, enabling one to record the images on the screen, which, after all, are not well lighted, hence the objectives should have a very short focus. Their weight reaches several kilograms for a diameter of from 10 to 15 cm.

For 25 years this was the only method in use, hence it reaped the benefits of all the research work and of all the improvements brought about by the technicians. These improvements included special condensers, special or interchangeable tubes, special fluorescent screens, film hypersensitized to such a degree that it could be preserved for only a few days, etc. The fluorescent screen is illuminated under a tension of

¹ Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13-17, 1937.

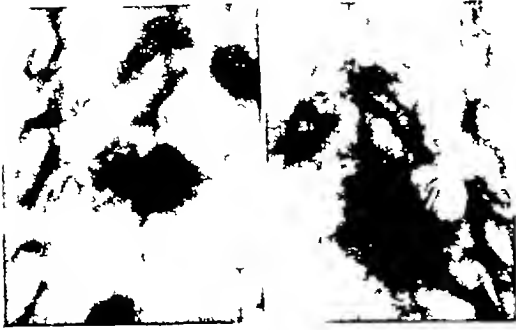


Fig 19 A

Fig 19 B

Fig 19 Isolated rarefaction of one articular process Figure 19-A normal, Figure 19-B diseased side



Fig 20 Fracture of the left superior articular process of the first lumbar vertebra Fracture line (small arrow), posterior displacement of the distal fragment (large arrow) Accident 16 months before, no callus formation

as made evident by narrowing of the apophyseal joint space, is the essential lesion in the different types of chronic spondylarthritis Calcification and ossification of ligaments is not pathognomonic of any particular disease

(4) A simple classification into (a) spon-

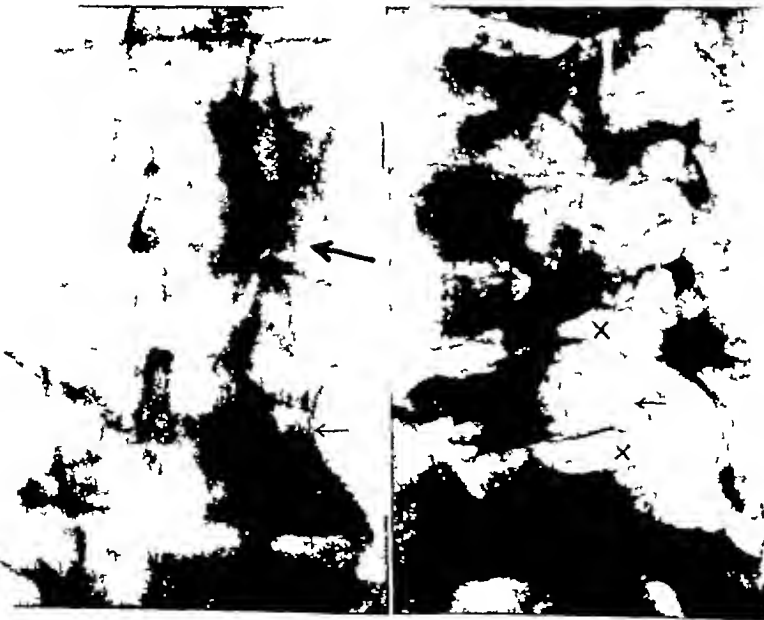


Fig 21 A

Fig 21 B

Fig 21 Congenital anomalies Figure 21-A, displacement of a supernumerary epiphysis by a trauma associated with destruction of intervertebral discs Figure 21 B absence of articular processes (x), gap formations (arrow)

dylitis, (b) spondylarthritis, and (c) spon- dylosis ossificans ligamentosa is proposed

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¹ Presented before the Fifth International Congress of Radiology in Chicago Sept 13-17 1937

PRIMARY BRONCHUS CARCINOMA

A DIAGNOSTIC AND THERAPEUTIC CONSIDERATION

By WALTER L. MATTICK, M.D., *Buffalo, N. Y.*

From the State Institute for Malignant Disease, Burton T. Simpson, M.D., Director

THE past two decades have witnessed a changing concept in our ideas regarding the pathology and diagnosis of primary bronchus carcinoma, but the proper therapy of these lesions still remains a much disputed issue. A summary review of the clinical and histopathologic diagnosis of this condition as seen here in our clinic is presented. Diagnosis and therapy will be stressed in the hope that eventually a sufficient series of case reports may be accumulated for future guidance in the most efficient methods of therapy of this serious lesion.

PATHOLOGY

Primary bronchus carcinoma was first diagnosed in this clinic in 1917. Since then, 73 other cases have been observed, but in only 65 has the clinical diagnosis, as suggested by history, physical, and x-ray examination, been substantiated by pathologic section. Of this histopatho-

logic material available for study, the diagnoses were confirmed in 31 by autopsy, in 31 by biopsy of the primary (generally at bronchoscopy), in 9 by biopsy from metastatic foci, and in two by examination of the lung tissue removed at operation.

Although we fully realize the futility of any gross pathologic classification of these growths, we strongly feel that the arbitrary division of such lesions into those of peripheral and those of central or hilar origins, as suggested by Rabin and Neuhof, serves the practical purpose of assigning the possible operability of such lesions. We have thus attempted to so classify these 65 proven cases from the pathologic and clinical data available and have found only seven that were located near the periphery of the lung in contradistinction to the central origin of the majority. The relations of such finding to the histologic structure as occasionally suggested will be discussed later. A survey of the frequencies of metastasis and extensions as observed both clinically and at postmortem follows (Table III). Bone metastasis was noted in 19 cases and was observed in the following order of diminishing frequency,

TABLE I — CARCINOMA BRONCHUS
AGE AND SEX INCIDENCE

Decades	Male	Female	Total Cases	Per-centage
70-79	3		3	4.1
60-69	12	3	15	20.5
50-59	23	5	28	38.3
40-49	15		15	20.5
30-39	4	2	6	8.2
20-29	5	1	6	8.2
	62 or 85 Per Cent	11 or 15 Per Cent	73	99.8

Male Female = 561

TABLE II — CARCINOMA BRONCHUS

(The number of cases observed by five year periods at the State Institute for the Study of Malignant Disease)

Years	Number
1917-21	4
1922-26	8
1927-31	13
1932-36	48
1917-36	Total
	73

TABLE III — METASTASES OR EXTENSION

Bones	38 per cent
Distant nodes	36 per cent
Lungs (other lung or lobes)	36 per cent
Regional nodes	34 per cent
Liver	20 per cent
Pleura	10 per cent
Adrenals	8 per cent
Kidneys	8 per cent
Pancreas	6 per cent
Esophagus	6 per cent
Brain	4 per cent
Pericardium	4 per cent
Auricular appendage and pulmonary vein	4 per cent
Intestines	2 per cent
Thyroid	2 per cent
Spleen	2 per cent
Diaphragm	2 per cent

tion every 2 cm.² The first tube I ever used was an ordinary 20 kv Philips Rotalix, with a₂ focus of 2.4 mm. This tube has from one-eighth to one-fifth of the erythema dose, according to the intensity employed.

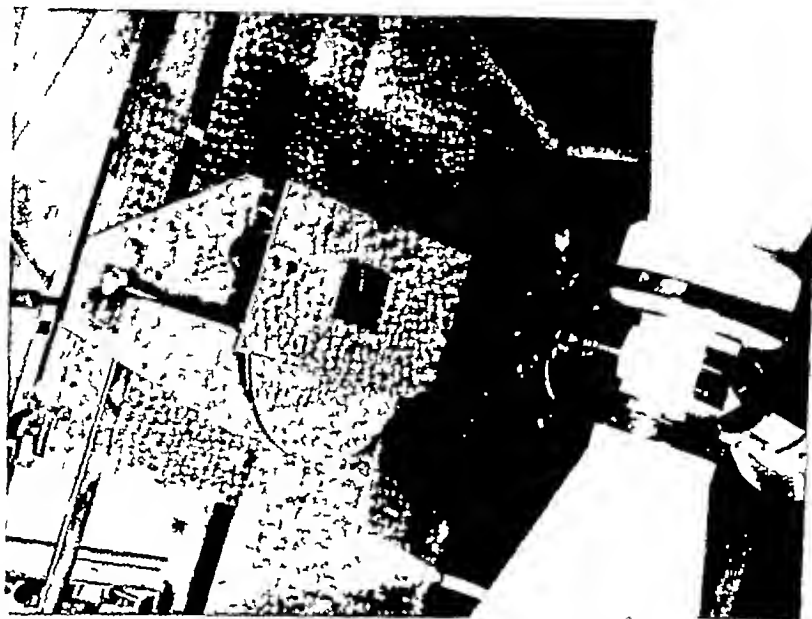


Fig 2

been in use in my laboratory for two years, and has been relied on for all the roentgenoscopies and roentgenographies of a busy service, beside this, it has served to record a score of films. Since the new year, I have been using a 2 mm Philips Rotalix. This tube, like the preceding one, also has been used in registering a score of films, and functions for all the needs of the service without showing any signs of wear. This tube bears a charge of 80 kv m. with 80 ma for 25 seconds, for lower tensions I have extended the exposure time up to 35 seconds. Since the tube functions the whole time the pictures are being taken, I have interposed between the subject and the tube a synchronous rotary leaded shutter (Fig 2), which protects the patient during the displacement of the film. The measurements taken with several ionometers prove that the patient receives only

A few months ago, thanks to the National Fund for Scientific Research, I undertook the construction of a new apparatus for direct roentgen cinematography (Fig 3), it is an apparatus with separate films which follow in succession at a cinematographic cadence. This apparatus is actually finished, and the first trials have been satisfactory. It was conceived in order to utilize greater active surfaces, permitting me to record more extensive regions, for instance, the bi-renal region during intravenous pyelography, the entire bladder, with urethra, etc. Here I have replaced the jerky movement with a continuous rotary movement. The apparatus contains a magazine filled with separate films perforated at the margin at one extremity of the lower edge of a slit 5 cm long by 5 mm wide. These films are superimposed in a magazine with slides at a distance of 3 mm from one another (Fig 4). The magazine is brought down gradually by a system of endless screws, resting

² The width of 179 mm. was chosen as it is the width at which the film manufacturers cut their 13 × 18 film.

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Primary bronchus carcinoma was first diagnosed in this clinic in 1917. Since then, 73 other cases have been observed, but in only 65 has the clinical diagnosis, as suggested by history, physical, and x-ray examination, been substantiated by pathologic section. Of this histopatho-

logic material available for study, the diagnoses were confirmed in 31 by autopsy, in 31 by biopsy of the primary (generally at bronchoscopy), in 9 by biopsy from metastatic foci, and in two by examination of the lung tissue removed at operation.

Although we fully realize the futility of any gross pathologic classification of these growths, we strongly feel that the arbitrary division of such lesions into those of peripheral and those of central or hilar origins, as suggested by Rabin and Neuhof, serves the practical purpose of assigning the possible operability of such lesions. We have thus attempted to so classify these 65 proven cases from the pathologic and clinical data available and have found only seven that were located near the periphery of the lung in contradistinction to the central origin of the majority. The relations of such finding to the histologic structure as occasionally suggested will be discussed later. A survey of the frequencies of metastasis and extensions as observed both clinically and at postmortem follows (Table III). Bone metastasis was noted in 19 cases and was observed in the following order of diminishing frequency,

TABLE I — CARCINOMA BRONCHUS
AGE AND SEX INCIDENCE

Decades	Male	Female	Total Cases	Percentage
70-79	3		3	4.1
60-69	12	3	15	20.5
50-59	23	5	28	38.3
40-49	15		15	20.5
30-39	4	2	6	8.2
20-29	5	1	6	8.2
62 or 85 Per Cent		11 or 15 Per Cent	73	99.8
Male		Female	= 56.1	

TABLE II — CARCINOMA BRONCHUS

(The number of cases observed by five year periods at the State Institute for the Study of Malignant Disease)

Years	Number
1917-21	4
1922-26	8
1927-31	13
1932-36	48
1917-36	Total 73

TABLE III — METASTASES OR EXTENSION

Bones	38 per cent
Distant nodes	36 per cent
Lungs (other lung or lobes)	36 per cent
Regional nodes	34 per cent
Liver	20 per cent
Pleura	10 per cent
Adrenals	8 per cent
Kidneys	6 per cent
Pancreas	6 per cent
Esophagus	6 per cent
Brain	4 per cent
Pericardium	4 per cent
Auricular appendage and pulmonary vein	4 per cent
Intestines	2 per cent
Thyroid	2 per cent
Spleen	2 per cent
Diaphragm	2 per cent

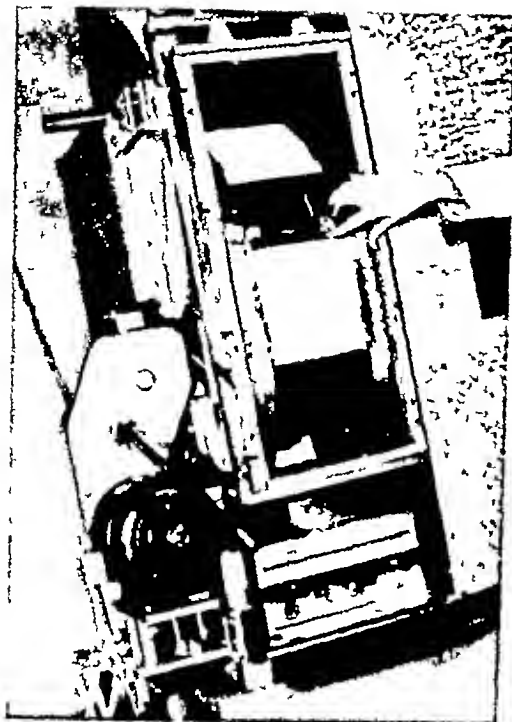


Fig. 1

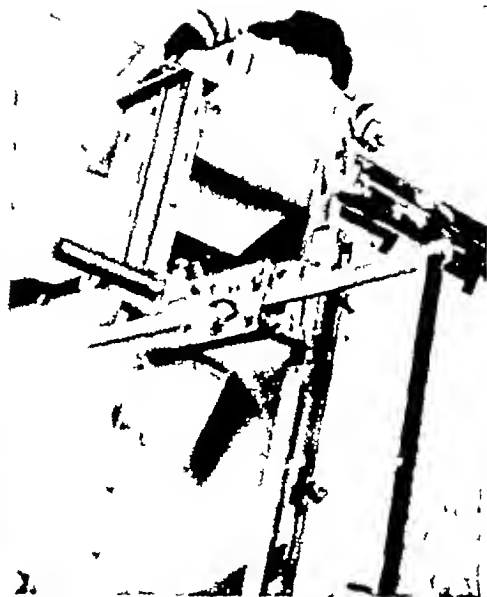


Fig. 2

six and a half images per second (number of turns according to the turncounter 390). This speed is sufficient to give the exact measure of the real speed of the movements to be studied, it also permits the study of the displacement mechanism.

Each image is doubled or trebled when the standard film is made, so as to reconstitute, according to the speed of the projection apparatus, the unity of movement in unity of time.

II ADVANTAGES AND DISADVANTAGES OF ROENTGEN CINEMATOGRAPHY

If we wish to give an absolutely objective opinion of the present advantages and disadvantages of the two methods of roentgen cinematography, we may advance the following considerations:

1 *Roentgenoscopic Method*—This method has certain undeniable advantages. In the first place, it permits the registration of movement as it appears upon the entire surface of the fluorescent screen (the entire thorax, the neck, the upper extremities,

etc.), and then the price of the film is moderate. As disadvantages might be mentioned the lack of clearness in the images, and the impossibility of registering accurately the movements of the deep organs (ureters, bladder, gall bladder, etc.). These defects may be explained by the fact that this method is based upon roentgenoscopy, the drawbacks of which in roentgen diagnosis are well known, furthermore, those faults are now exaggerated because, in order to record the images, the fluorescent screen must be brilliantly illuminated by opening the diaphragm widely, and throwing on the screen a powerful light. It follows that the details of the roentgenoscopic image, which are already insufficient, are lost still more, and that the outlines of the organs become blurred. And beside, these images must be projected a great distance from the screen, at a much accelerated speed, with a wide open objective.

2 *The Direct Method*—It also has its disadvantages. In the first place, the higher price of the original film, and then the fact that the film must be transferred to a size suitable for projection. However, the price is not at all prohibitive, and

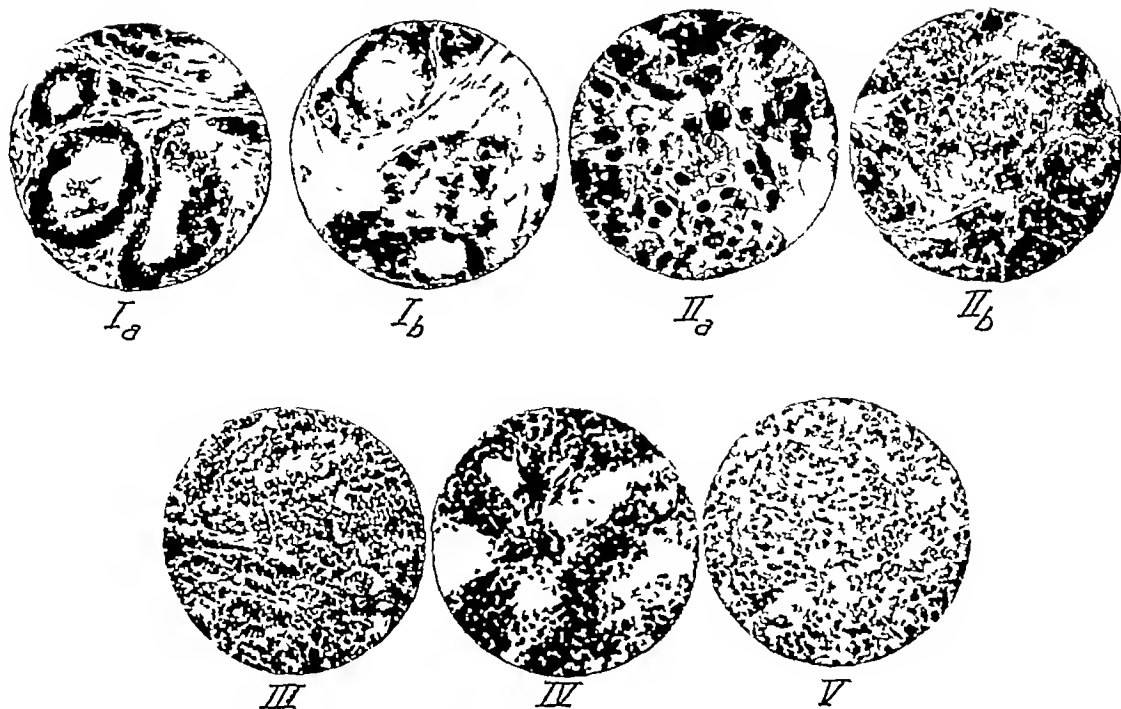


Fig 1 The predominating histopathologic tendencies of bronchus carcinoma, arranged according to classification in Table IV. Special attention is called to the marked pleomorphic tendencies of this lesion, which in a few instances made such artificial grouping impossible.

however, be discussed more fully under treatment. No case of adenoma or carcinoid was seen although we were on the lookout for such in our material; neither could we observe any correlation between the age period of occurrence and the histopathologic grouping as observed by Geschickter in his series of 62 cases (Table V).

In our earlier records, it was interesting to note the frequency with which this lesion was confused with the lymphocytic type of lymphosarcoma, five such cases being discovered. Mention should be made here of the early work of Weller and others who have assisted in bringing to light the fallacy of such former erroneous concept. Seven cases in this series had previously been classified as "endothelioma of the pleura." We, like Stout, doubt the existence of such an entity, as on review of the sections all of these cases turned out to be bronchus carcinomas with extensive pleural involvement, showing the usual cellular tendencies as represented in the above classification. Five of these were classified by us in Group IV.

RADIOGRAPHY

There is no single finding or group findings that is absolutely pathognomonic of bronchus cancer. In fact, some early cases may apparently pass by routine chest roentgenography without arousing suspicions of this lesion (Fig 2). It should, however, always be the custom to take at least postero-anterior and lateral radiographs of the chest in all cases in which the history or physical examination suggests

TABLE VI—CARCINOMA BRONCHUS

(Anatomical Location of Primary vs Histopathologic Grouping)

Primary Tumor	Central or hilar location	49
	Peripheral	7
	Indeterminate	6
		<hr/> 62

(Seven Peripherally Located Tumors vs Histopathologic Grouping)

I _a	I _b	II _a	II _b	III	IV	V
2	0	2	2	0	1	0

Note. From the above there was no significant correlation between predominating pathologic trend or grouping and the peripheral location of the primary lesion.

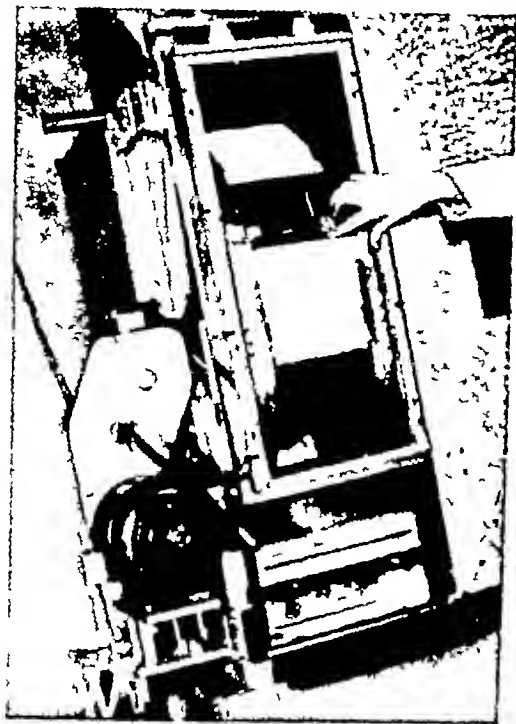


Fig 5

six and a half images per second (number of turns according to the turncounter 390) This speed is sufficient to give the exact measure of the real speed of the movements to be studied, it also permits the study of the displacement mechanism

Each image is doubled or trebled when the standard film is made, so as to reconstitute, according to the speed of the projection apparatus, the unity of movement in unity of time

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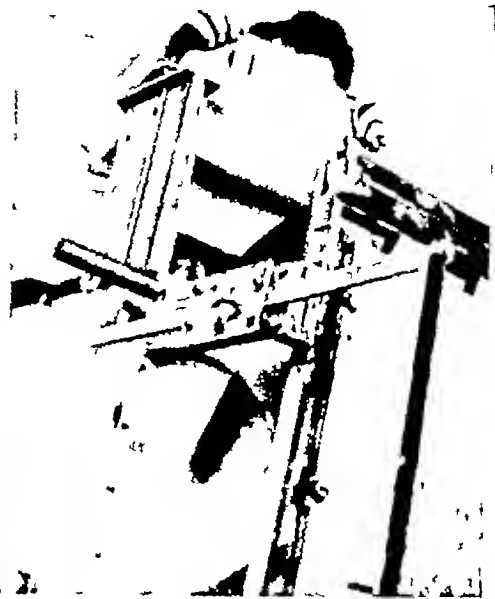


Fig 6

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ance with a similar study by Manges and Farrell shows the following predominating x-ray characteristics in 38 cases of films available for study

	50 Cases (Manges and Farrell)	38 Cases (S I M D)
Atelectasis	40 per cent	42 per cent
Increased marking	28 per cent	21 per cent
Tumor mass	24 per cent	13 per cent
Abscess or cavitation	6 per cent	9 per cent
Pleural effusion	2 per cent	15 per cent

The percentage variation in either series is of little moment because of the small number of cases involved except that it may tend to emphasize the probability of our cases being the more advanced when seen by us

THERAPY

In accordance with the most approved views, the type of therapy will depend on anatomic localization of the lesion, *i.e.*, whether central or peripheral, and the histopathologic structure as shown by biopsy. The ideal cases for lobectomy or pneumectomy should be the peripherally located mass not accessible to the bronchoscope, with no hilar, mediastinal, or metastatic involvement or a lesion found on bronchoscopic biopsy to contain no mitotic figures, not too central in location and more recently classified as adenoma or carcinoid. In fact, a critical review of the cases surviving a year or more after such radical surgical procedures would lead to the possible suspicion that many of such cases to date might fall into this carcinoid category. Two of the cases of typical bronchus carcinoma in our series subjected to total or partial extirpation of the lung, died of extension. In fact, Kernan doubts the efficacy of such procedures in proven carcinoma and states that he has yet to observe such a cured case. Overholt, on the other hand, reports two cases alive, respectively, 20 and 14 months following pneumectomy for carcinoma.

Whereas the surgical outlook may be generally unalluring at the present state of our knowledge, the radiologic prospects

are about as bad or worse. The experiences of the Memorial Hospital as cited by Stewart, the Mayo Clinic experience as cited by Vinson, and that at Bellevue as recorded by Kernan surely leave little optimism for radiologic therapy. There are only a few authentic cases to be found in the literature of radiologic arrests of this disease, notably one of Gantenberg's with a three-year regression followed by recurrence, one of Kahler's of the "basal cell type" alive after nine years, and one of Myer's alive and well after three years.

Following the suggestion of Ehrlich and Hauptman, the writer has adopted the x-ray technic of Herrnheiser in addition to radon seeds and diathermy in cases in which it is suitable, in the latter cases of this series. This type of external irradiation consists in using large total doses of protracted x-ray therapy of long target distance through four or more portals directed toward the tumor, up to a total of 12,000 r. This has apparently given marked symptomatic and subjective improvement for 18 months in one recent case, although only slight increased aeration is noted in the chest films. The supplemental use of radium element needles in the bronchus, according to the suggestion of Meland, is applicable to selected cases.

A review of these cases according to histopathologic grouping and survival periods following diagnosis and treatment has been made and fails to reveal any significant relationship as regards these factors, neither is there in evidence any reason to suspect from this small series that any one histopathologic group may be any more or less malignant, be any more prone to metastasis or rapid extension, or more radiosensitive than any other group. This finding is quite in accord with the original postulated origin of bronchus carcinoma from the basal cell deposits of the mucosa and quite in line also with the general pleomorphism so much in evidence in reviewing this material.

Therapeutic results are very difficult of evaluation on account of the fact that most

RADIOTHERAPY OF BLADDER CARCINOMA FIVE-YEAR RESULTS FAILURES FUTURE THERAPY¹

By BENJAMIN S. BARRINGER, M.D., Memorial Hospital, New York City

THE three-year cures by radium of 215 cases of bladder cancer show 67 cases, or 31.7 per cent. The five-year cures show 52 cases, or 24.1 per cent, a drop of 7.6 per cent. The total number of cases in which the bladder has become cancer-free are 96, or 44.6 per cent.

These cases were treated cystoscopically and by suprapubic implantation.

They include all cases, no matter how extensive, in which the bladder was opened. Radium was implanted in many very extensive carcinomas with the idea of controlling more cases. Notwithstanding this, five-year cures fail in about three-fourths of all cases.

PATHOLOGY OF CURED CASES

Papilloma with atypical cells	5
Papillary carcinoma	14
Infiltrating carcinoma	16
Adenocarcinoma	1
Grade I	10
Grade II	30
Grade III	12
Grade IV	2
No pathology	6
	96

Of these cases, 36 were not graded, 16 cases were infiltrating carcinoma. The 10 cases of Grade I were not papilloma but were graded according to the Memorial grading, that is they were papillary carcinoma. In the six cases in which there was no pathology the diagnosis was made clinically, either because of a sloughing tumor or by induration felt vaginally or rectally.

It is noteworthy that but two Grade IV have been controlled. With proper methods of irradiation, I do not believe that the Grade IV carcinoma should be more difficult to control than the other grades. If the control is by operation alone, of course that is a different matter. As Grade IV bladder carcinomas are relatively

rare, it would seem that the percentage of cures is but slightly less than those of other types.

TIME THAT CURED CASES HAVE BEEN WELL

Less than 1 year	9
1 to 2 years	6
2 to 3 years	12
3 to 4 years	12
4 to 5 years	5
5 to 7 years	19
7 to 10 years	19
More than 10 years	13
More than 20 years	1
	96

PATHOLOGY OF DEAD CASES

Papilloma with atypical cells	6
Papillary carcinoma	10
Infiltrating carcinoma	22
Grade I	3
Grade II	20
Grade III	34
Grade IV	10
No pathology	17

All that we can glean from this table is that the infiltrating carcinomas are more difficult to cure than the papillary carcinomas.

TIME UNTIL DEATH OF UNCONTROLLED CASES

Less than 1 year	68
1 to 2 years	29
2 to 3 years	11
3 to 4 years	4
4 to 5 years	4
5 to 7 years	5
7 to 10 years	1
More than 10 years	1

Most patients die in the first year and the reason for this first-year death rate is unquestionably severe infection of the bladder and kidneys. Probably but few of those who die in the first year, actually die of carcinoma.

Multiplicity of Tumors (96 Cases)—The Carcinoma Registry has emphasized that bladder cancers are more often multiple than single. They have even seen fit to change the pathological diagnosis from papilloma to carcinoma on the clinical basis that carcinomas are multiple. Unquestionably from the clinical stand-

¹ Presented before the Fifth International Congress of Radiology at Chicago, Sept. 13-17, 1937.

HERRNHEISER G Weitere Erfahrungen mit der Röntgenbehandlung maligner Bronchus und Lungengeschwülste. Strahlentherapie 1935, 52, 425-459

KAHLER, H Durch neun Jahre geheilter Fall eines histologisch nachgewiesenen Bronchuskarzinoma Wien Klin Wchnschr, 1933, 46, 1404

KERNAN JOHN D Jour Am Med Assn July 25 1936, 107, 260 (discussion)

OVERHOLT, RICHARD H Primary Carcinoma of the Lung Early Diagnosis and Treatment of Pneumonectomy New Eng Jour Medicine, Jan 16 1936, 214, 93-100

RABIN, C B, and NEUHOF, H A Topographic Classification of Primary Cancer of the Lung Its

Application to the Operative Indication and Treatment. Jour Thoracic Surg, December, 1934, 4, 147-164

STEWART, FRED W Radiosensitivity of Tumors Arch Surg, December, 1933, 27, 979-1064

STOUT, ARTHUR PURDY Human Cancer Lea & Febiger, Philadelphia 1932

VINSON, P P Primary Malignant Disease of the Tracheobronchial Tree A Report of 140 Cases Jour Am Med Assn, July 25, 1936, 107, 258-261

WELLER, C V Entdifferentiation in Primary Carcinoma of the Bronchi and Lungs Jour Cancer Research October, 1929 13, 218-238

VARIOUS FORMS OF RADIATION IN U.S.L.

I *Radon Seeds*—These have constituted the best method for both suprapubic and cystoscopic application of radium.

II *X-ray Alone*—Much has been written of late about the control of bladder cancers by x-ray alone. Notwithstanding repeated and persistent attempts on our part to control the more difficult types of bladder cancer, deep x-ray therapy has signally failed. The reports of cases so treated have been singularly inadequate, both as to pathology, time of cure, and the failure in at least one such report to mention the essential fact that radium was an adjunct to the x-ray treatment. The use of x-ray in the milder forms of bladder cancer or in papilloma, which could easily be controlled by cystoscopic fulguration or radium application, is, to me, unjustifiable. I have seen, after prolonged x-ray irradiation, extremely severe effects, and I have seen two patients die from skin destruction after such irradiation. In one of these an infiltrating tumor had been controlled and the bladder was tumor-free. Most bladder cancers are quite radio-insensitive. As we at present know how to handle deep x-ray therapy, it is not alone sufficient; it might perfectly well be used as an adjunct to operation or to radium in the higher forms of malignancy, particularly Grade IV.

III *X-ray plus Radon Seeds*—I have attempted in three cases of ulcerated extensive infiltrating carcinoma to combine these two, the radium applied either cystoscopically or suprapubically. These three patients have all succumbed.

IV *Fulguration*—The statistics of Braasch still constitute the only series in

which a small number of infiltrating tumors have been controlled by fulguration.

V *Fulguration and X-ray*—Considerable work has been done lately with the instrument used for transurethral prostatectomy in fulgurating extensive bladder tumors, followed by x-ray therapy. No extensive series, so far as I know, has been reported. It would seem that fulguration does not work as an adjunct to x-ray, as does radium.

VI *Pre- or Post operative X-ray Irradiation*—Theoretically either of these procedures might so partially devitalize tumor cells that the operative removal might result in a larger number of cures. I believe that to be more a theoretical than a practical consideration. At any rate, I have not seen any reported series to substantiate this.

VII *Radium Application*—The application of a large amount of radium, held against a tumor for periods of one hour each by means of the cystoscope and under direct vision, might seem the answer to the control of more cases of large ulcerating bladder cancers, which are virtually beyond our grasp at present. We have several such cases which we will report later in which this method has been effective, particularly as used in conjunction with mild deep x-ray therapy. The infection in the bladder would seem to be less than when radon seeds are implanted and the suprapubic operation is omitted. Only further work can determine, however, whether we will be able to extend the number of five-year controls of bladder carcinoma.

In Table III the yearly incidence of fistulæ is shown to be, in general, slightly higher for the patients treated by divided dosage than if treated by massive dosage. However, the total fistula incidence for the years 1935-1936, inclusive, is practically the same for the two methods. The low incidence in 1936 is thought to be due to the increased interval (at least one month for divided dosage and at least two to three weeks for massive dosage) between the completion of the roentgen therapy and the radium application. This time factor was increased in 1936, and radium was not given until the x-ray reaction had completely subsided.

TABLE IV—YEARLY FISTULA INCIDENCE IN PRIMARY CERVIX CARCINOMA COMPARED AS TO STAGE OF DISEASE AND METHOD OF THERAPY

Treatment	Years	Total		
		No	Fis- tulæ	Percentage
X-ray and Radium	1933-1936	499	21	4 21
X-ray Only	1933-1936	30*	0	Only 1 alive (1934)
Radium Only	1933-1936	38**	0	15 are alive
Total Treated	1933-1936	567	21	3 7
No Therapy***	1933-1936	15	2	13 3
Total Treated	1916-1932	2 852	94	3 2
No Therapy***	1916-1932	96	7	7 2
Total Treated	1916-1936	3,419	115	3 3
Total Not Treated***	1916-1936	111	9	8 1

* All advanced

** Nine were early cases

*** Too advanced at first visit

In Table IV the summary of the fistula incidence according to method of therapy, if any, shows the incidence of fistulæ to be more than twice as great in untreated as in treated patients. This holds true in the patients treated from 1933 to 1936, and in the totals as well as in the previously published figures for 1916-1932. The 30 patients treated by x-ray only were all too advanced for any but palliative therapy, and the absence of fistulæ in the group as compared with the relatively high fistula incidence in untreated patients suggests that therapy prevents rather than causes fistula formation.

CONCLUSIONS

1 Vaginal fistula incidence in carcinoma of the cervix is more than twice as high in untreated as in irradiated patients.

2 Fistulæ are probably prevented more often than caused by irradiation therapy.

3 Divided dose roentgen therapy increases fistula incidence only slightly, if at all.

107 East 67th St

BIBLIOGRAPHY

- (1) SMITH, FRANK R. Am Jour Cancer, September 1934, 22, 52-58.
- (2) GRAVES R C, KICKHAM C J E and NATHANSON, I T. Surg Gynec and Obst, December 1936, 63, 785-793.
- (3) BEHNEY C A. Am Jour Obst and Gynec., 1933 26, 608-614.
- (4) WILLIAMS. British Gynec Jour 1896 11, 529.

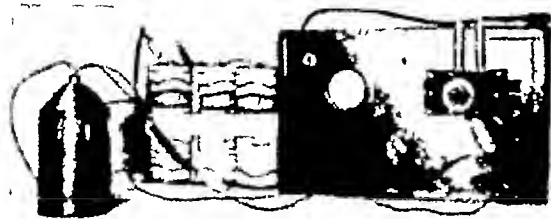


Fig. 2



Fig. 3

ferences in shading, even though slowing down the response. This is of no consequence in this instance as we do not require the instant indication so necessary to the proper functioning of other photoelectric devices, e.g., television, relays, etc. We are interested only in accurate needle deflection, and a few seconds lost in obtaining this necessary accuracy is unimportant.

The wiring diagram (Fig. 1) is the one used in the instrument first constructed. It is undergoing almost daily alterations for obvious reasons.



Fig. 4

The illuminator must be finished a dull black inside and the bulbs should be frosted or color filters used. The sensitivity of response seems to be greater when working with as little illumination as possible. The light source must be well back of the P.E. cell and preferably multiple. In my instrument I am using three 3.8 v. flashlight bulbs.

The hook up is a modification of the Pest Universal Photoelectric set. I have retained the sensitive relay in order to test the P.E. cell and to demonstrate it to my colleagues. It also serves to protect the millimeter, for the full output of the cell even through a 5,000 ohm series resistance would be too much current and might injure the millimeter. A double pole double throw switch is used to cut in or out either the relay or the meter, and the switch is always left on the relay side after use.

OPERATION

We first established a zero or starting response. For this purpose the abdomen of a young blond female was used. The meter was set arbitrarily at 0.5 ma. It is to be understood that this figure has no meaning or value in itself, but only when compared with other subsequent readings on the same individual, or other primary readings, or 'zeros' obtained from the natural complexions of other individuals. The light source in the illuminator is then turned on and the deflection of the needle noted. This happened to be 0.720 ma, or a deflection of 0.220. This experiment was repeated a number of times and was always

the same except when line voltage fluctuations occurred. This made it necessary to redesign the voltage supply, more of which in a later report. Next, a much darker complexioned individual was taken and a reading of 0.660 obtained, showing that the intensity of reflected luminosity was less in this individual. Other experiments with ultra violet light erythema estimations have been and still are being carried out. While much still remains to be done, I have gone far enough in this thing to believe that variation in erythema can be determined with more consistency by the P.E. cell than by depending on the human eye and with a degree of accuracy well within practical limits. Thus standards of erythema could be established for different values of $(\lambda + r)$ and supplied in proper form with each instrument, also several standards of normal complexions could be determined in the same way. The light and color response of the P.E. cells would be checked against a standard so that each instrument could be adjusted by the user for zero, threshold erythema, and so on, with the necessary accuracy.

I believe there is a possibility that an instrument of this kind can be produced which will fulfill the desire of many for a biological unit or the statement of x-ray dosage in terms of erythema.

As previously stated, there are many problems to be solved, but I believe they are of a minor nature.

Figures 2 and 3 show the unit in and out of the cabinet, Figure 4 the unit in use on a pa-

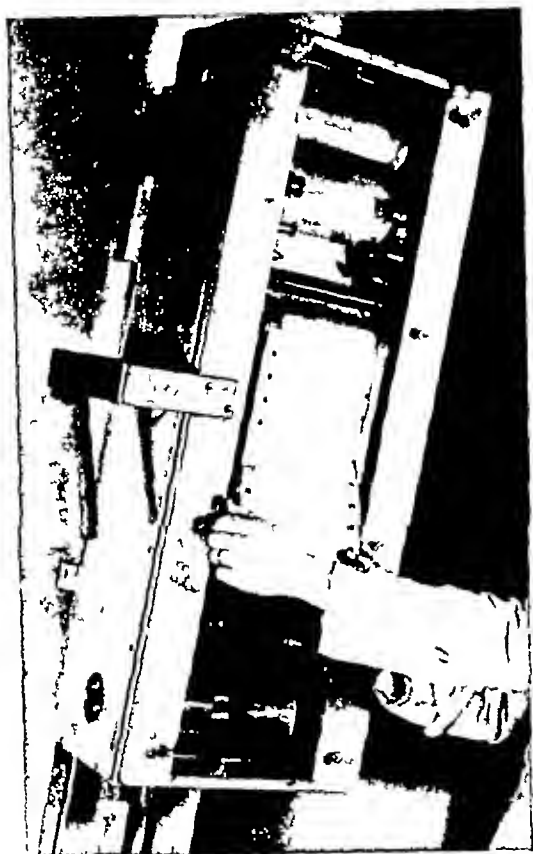


Fig 1

screens While in the ordinary cinema, working at 16 pictures a second, only 35 cm are unreeled per second, here about two meters must be unreeled, furthermore, the utilized surface must be unreeled from the intact reel as often as 16 times per second, must be brought before the camera gate and lens, completely immobilized without the slightest friction on the surfaces (in order to avoid scratches and static discharges), and also must be held firmly between the intensifying screens, exposed, released, and rolled on the exposed reel. One can easily conceive how the mechanism must be subjected to great jerky efforts, and the risk of vibration for the camera.

As for intensifying screens, they gave me no trouble, the rest was nothing at all. For films, I use Gevaert's ordinary films, which were graciously offered to me by the firm. The films have a marginal perfora-

degree. It seems at least possible that these bony changes were so extensive that proper movement of the skeleton was interfered with, making the animal fall easy prey to one of the many large carnivora that abounded at the time.

A CASE OF SILVER INJURY TO CHEST WALL AND DIAPHRAGM

By I. W. ROWE, M.D., Lincoln, Nebraska

Patient C. S., male, 24 years of age, occupation, student.

Final Diagnosis—Contusion of chest wall, followed by (1) emphysema of the chest wall, (2) hemorrhage, subdiaphragmatic, and (3) secondary hemorrhage, intra pleural.

History—While at work on an auditorium stage at 1145 Ave. J, on March 25, 1937, the patient lost his balance and fell backward from an 18 foot ladder. About eight feet from the floor he struck a painter's jack with the right side of his chest. This was a steel bar one half by one and one half inches, and the force of the impact was sufficient to bend it to an acute angle. This blow whirled the patient around so that he landed on his feet and then toppled backward, the ladder falling over his legs. Immediately he experienced considerable pain over the seventh to ninth ribs in the right axilla and in the back at the same level. He could feel crepitation in the axillary soft tissues and in the back. He was immediately given a quarter gram of morphine sulphate and sent to the hospital by ambulance.

Past History—Two years before, in football, he fractured two ribs on the left side. General health was good, and he participated in school athletics.

Family History—Not remarkable.

Physical Examination—Thorax large, swollen, discolored area about eight inches in diameter centering over the seventh or eighth rib in the right axillary line. The tissue crepitated on palpation. Resistance below right costal region and elevation of diaphragm noted. Respiration painful but aeration of the right lung normal except that the diaphragm was high and immobile (Figs. 1 and 2).

Pulse, 52, temperature, 98.6°, respiration, 18, hemoglobin, 105 per cent, white blood cells, 22,210 (March 26, 1937).

Clinical Course—Second day temperature, 100.8°, pulse, 100, respiration, 30. Sixth day temperature, 98.6°, pulse, 80, respiration, 18. Patient left hospital with some tenderness in right side but fairly comfortable.

He was examined frequently after leaving the hospital. These examinations revealed a lowering of the diaphragm and lessening of the subdiaphragmatic dullness. Patient was comfortable, keeping to his bed most of the day under protest. On April 21, 1937, after an x-ray examination, he had distressingly sharp pains around the region of the umbilicus. These continued and then partially subsided after five or six days, increased again, with elevation of temperature in afternoons, and with respiratory embarrassment.

The patient was re-admitted to the hospital on April 26, 1937. His roentgen examination was as shown in Figure 3. Temperature, 100°.



Fig. 1 Examination made immediately after the injury shows (1) emphysema in the soft tissue overlying the right side of thorax, (2) lungs negative, heart not remarkable.



Fig. 2 Decrease of air in soft tissue of the chest wall, subdiaphragmatic hemorrhage (March 27, 1937).



Fig. 3 Sudden onset of pain in right chest, dyspnea and cough (April 26, 1937). Right pleural sac filled with blood proven by paracentesis, collapse of lower middle and most of upper lobe.

from 60 to 100 kv or more, and with an intensity of from 60 to 80 ma (except Djan, 15 to 25 ma) The roentgenoscopic method was originated in 1910 by Lomon and Comandon, who utilized an objective of F 1 55 In 1928, Luboshez presented to the Congress at Stockholm an objective with a focus of 1 Later on, followed in succession Janker F 0 99, Russell Reynolds F 0 85, Djan F 0 75 to 0 55, and at last, in America F 0 50

(B) *Direct Roentgen Cinematography*—Aside from the experiments by Prof Groedel, of Bad Nauheim, carried out through the aid of the firm Siemens, Reiniger-Verfa, of Berlin, and those by Porcher, of Paris, in 1926, up to the present time this method has not been in existence at all Groedel's and Porcher's efforts, unfortunately, were failures and remained almost entirely unknown

Four years ago, after many technical experiments and calculations intended to solve the mechanical difficulties, I became convinced that this method could actually be put into practice, and after two years of hard work, I succeeded in developing my first roentgen cinematographic apparatus (Fig 1) My object was not to roentgen cinematograph entire organs but to reproduce the cinematic picture of parts of diseased organs, the study of which has practically escaped the roentgenoscopic method, and even ordinary roentgenoscopy, for instance, the gall bladder, the urinary system, hystero-graphy, etc My aim was to develop a practical method using only ordinary material, generator tubes, films, screens, etc, capable of bringing some light upon the normal and pathologic morphology of the organs in question In order to attain this object, I produced two apparatus

The first apparatus, with reel film, is based upon the principle of the ordinary motion picture machine, with intermittent motions by a Maltese cross The difficulties of adaptation at the outset lay in the size of the film to be employed, as each picture measured 120×140 mm, and later, in the necessity of using intensifying

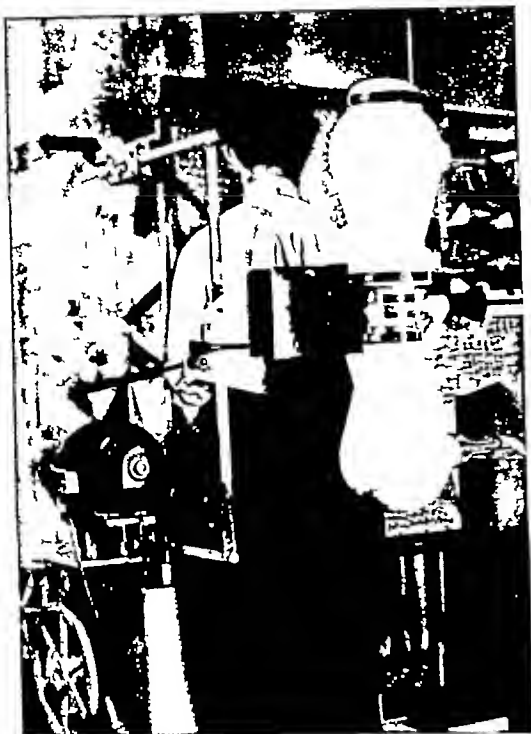


Fig 3

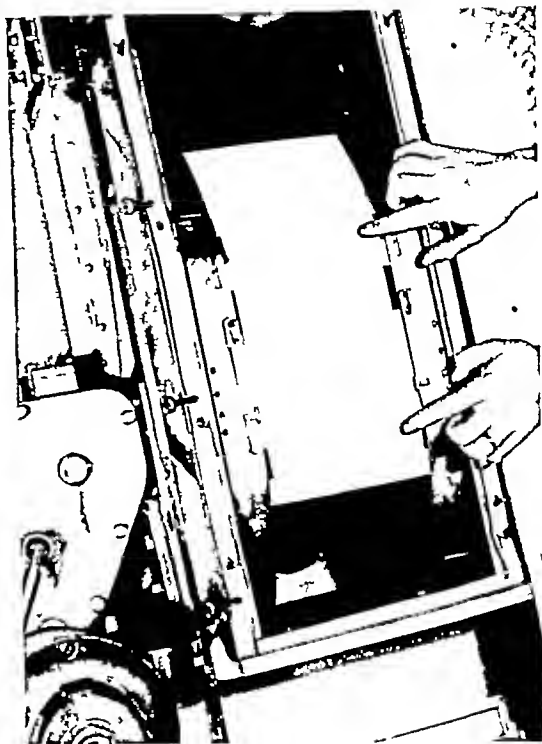


Fig 4

on an axis, bearing a primary series of retaining rods which keep the films between the intensifying screens (Fig 5). At this moment the film is immobilized by a compressor, similar to that of the preceding apparatus during the exposure, then other releasing rods lead it to a receiving magazine (Fig 6), where a system of hooks insures the release and the piling of the films in a receptacle, which is closed by a sliding cover, after which it is taken to the dark room.

For roentgen cinematography of the cavities of the organs of the human body, the image of which is usually veiled by the oblique and secondary rays, I place before the camera gate and lens a movable, anti-diffusion, rotating grid. The speed of displacement of the rotating grid may be regulated independently from that of the other parts of the apparatus. I use a rotation speed of 240 turns a minute. Since the only movable anti-diffusion appliance that could be fitted to my apparatus was one with continuous rotation, I chose the Siemens

rotary model, but in so doing a great difficulty had to be overcome. Indeed, since I could not, for such a short exposure, diminish the area of the image, which was already reduced by registering on it the axis of rotation encircled by some halo, I decentered the anti-diffusor in such a manner that only the most marginal portion possible was used, namely, that with the greatest displacement speed, but with this system I found in the median portion of the image some streaks formed by the lead strips. I decentered the tube a trifle (2°) so that the normal ray should slant slightly toward the periphery, thus, without distorting the image, I avoided the streaks previously mentioned by affording the rays a better passage between the strips of the anti-diffusing grid.

It is evident that with the anti-diffusion grid I do not obtain 16 images a second when using the potentials which I have specified, and which, while giving a satisfactory return, guarantee at the same time the integrity of the tube. I have obtained

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note—Will secretaries of societies please co-operate with the Editor by supplying him with information for this section

CALIFORNIA

California Medical Association Section on Radiology—*Chairman* John D. Lawson, M D, 1306 California State Bldg, Sacramento *Secretary*, Karl M. Bonoff, M D, 1940 Wilshire Blvd, Los Angeles Meets annually with California Medical Association

Los Angeles County Medical Association Radiological Section—*President* John I. Chapman, M D, 65 N. Madison Ave, Pasadena, *Vice president*, E. N. Fildahl, M D, 1211 Shatto St., *Secretary* Mel L. Pindell, M D, 675 South Fernis Ave. *Treasurer* Henry Snure, M D, 1111 Hope Street. Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club—*Chairman*, Raymond G. Taylor, M D, 1212 Shatto St, Los Angeles *Secretary*, I. Henry Garland, M D, 150 Sutter St, San Francisco

San Francisco Radiological Society—*Secretary*, L. H. Garland, M D, 150 Sutter Street. Meets monthly on first Monday at 7:15 P M, alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club—*President* John S. Bousslog, M D, 218 Metropolitan Bldg., *Vice president* Sanford Withers, M D, 101 Republic Bldg., *Secretary*, Ernst A. Schmidt, M D, Colorado General Hospital, *Treasurer*, H. P. Brandenburg, M D, 165 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology—*Chairman*, Kenneth K. Kinney, M D, 29 North Street, Williamamie, *Vice chairman* Francis M. Dunn, M D, 100 State Street, New London *Secretary-Treasurer*, Max Clinman, M D, 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society

FLORIDA

Florida State Radiological Society—*President*, Gerald Raap, M D, 168 S. E. First St., Miami, *Vice-president*, H. O. Brown, M D, 404 First Nat'l Bank Bldg., Tampa, *Secretary-Treasurer*, H. B. McEuen, M D, 126 W. Adams St., Jacksonville

GEORGIA

Georgia Radiological Society—*President*, James J. Clark, M D, Doctors Bldg., Atlanta, *Vice president*, William F. Lake, M D, Medical Arts Bldg., Atlanta, *Secretary-Treasurer*, Robert C. Pendergrass, M D, Prather Clinic, Americus. Meetings twice annually in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society—*President*, David S. Beilin, M D, 411 Garbald Ave., *Vice president*, Chester J. Challenger, M D, 3117 Logan Blvd., *Secretary-Treasurer*, Roe J. Maier, M D, 7752 Halsted St. Meets second Thursday of each month September to May, except December.

Illinois Radiological Society—*President*, Cesare Gianturco, M D, 602 W. University Ave. Urbana, *Vice president*, Fred H. Decker, M D, 802 Peoria Life Bldg., Peoria *Secretary-Treasurer*, Edmund P. Halley, M D, 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section of Radiology—*President* Roswell T. Pettit, M D, 728 Columbus St., Ottawa *Secretary* Ralph G. Willy, M D, 1133 N. Leavitt St., Chicago

INDIANA

Indiana Roentgen Society—*President*, J. N. Collins, M D, 23 E. Ohio St., Indianapolis *President elect* Stanley Clark, M D, 108 N. Main St., South Bend, *Vice president*, Juan Rodriguez, M D, 2903 Fairfield Ave. Fort Wayne, *Secretary-Treasurer*, Clifford C. Taylor, M D, 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society

MARYLAND

Baltimore City Medical Society, Radiological Section—*Chairman*, Marcus Ostro, M D, 1810 Eutaw Place *Secretary* H. E. Wright, M D, 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society

MICHIGAN

Detroit X-ray and Radium Society—*President* E. W. Hall, M D, 10 Peterboro Street *Vice president*

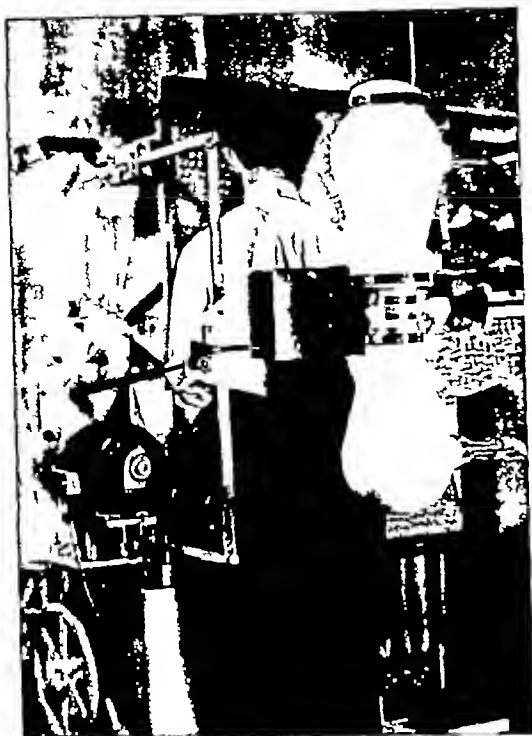


Fig 3



Fig 4

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beth's Hospital, Youngstown, *Secretary Treasurer*, Harry Hauser, M D Cleveland City Hospital Cleveland Meetings at 6 30 P M at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April inclusive

Radiological Society of the Academy of Medicine (Cincinnati Roentgeologists)—*President*, George Benzing, M D, St Elizabeth Hospital Covington Ky, *Secretary-Treasurer*, Justin E McCarthy M D, 707 Race St, Cincinnati, Ohio Meetings held third Tuesday of each month

PENNSYLVANIA

Pennsylvania Radiological Society—*President*, Sydney J Hawley, M D Geisinger Memorial Hospital Danville, *First Vice president*, William J McGregor M D 744 Franklin Ave, Wilkesburg, *Second Vice president* Oscar M Weaver, M D 12 S Main St Lewistown, *Secretary Treasurer* Lloyd E Wurster M D, 416 Pine St, Williamsport, *President elect* Charles S Caldwell, M D 520 S Arken Ave Pittsburgh Annual meeting, May, 1938 Exact date and place to be decided

Philadelphia Roentgen Ray Society—*President* Thomas P Laughery, M D, Germantown Hospital, *Vice president*, Elwood E Downs, M D Jeans Hospital Fox Chase *Secretary*, Barton H Young M D Temple University Hospital, *Treasurer*, R Manges Smith M D Jefferson Hospital Meetings first Thursday of each month from October to May Thompson Hall College of Physicians 19 S 22nd St 8 15 P M

The Pittsburgh Roentgen Society—*President*, F I Schumacher, M D, Jenkins Arcade, *Secretary* H N Mawhinney, M D, Mercy Hospital Two Fall and two Spring meetings at time and place designated by president

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

South Carolina X ray Society—*President* Robert B Taft M D 105 Rutledge Ave Charleston *Secretary Treasurer* Hillyer Rudisill, M D Roper Hospital, Charleston Meetings in Charleston on first Thursday in November also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society

TENNESSEE

Memphis Roentgen Club—Chairmanship rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

Tennessee State Radiological Society—*President*, H S Shoulders M D 246 Doctors Bldg, Nashville, *Vice president* S S Marchbanks, M D, 508 Medical Arts Bldg, Chattanooga *Secretary Treasurer*, Franklin B Bogart M D, 311 Medical Arts Bldg, Chattanooga Meeting annually with State Medical Society in April

TEXAS

Texas Radiological Society—*President* R G Giles M D, Medical Arts Bldg San Antonio, *President elect*, Jerome H Smith M D Shannon West Texas Memorial Hospital San Angelo *First Vice president*, C F Crain M D, 416 Chaparral St Corpus Christi, *Second Vice president*, M H Glover, M D, 904 8th St, Wichita Falls *Secretary Treasurer*, G D Carlson M D, 3121 Bryan St, Dallas Meets annually San Antonio is place of meeting Oct 22 1938

VERMONT

See New England Roentgen Ray Society

VIRGINIA

Radiological Society of Virginia—*President* Fred M Hodges, M D 100 W Franklia St Richmond, *Vice president* L F Magruder M D, Raleigh and College Aves, Norfolk *Secretary*, V W Archer M D University of Virginia Hospital Charlottesville.

WASHINGTON

Washington State Radiological Society—*President*, H E Nichols M D Stimson Bldg Seattle *Secretary* T T Dawson M D Fourth and Pike Bldg Seattle Meetings fourth Monday of each month at College Club

WISCONSIN

Milwaukee Roentgen Ray Society—*Secretary* S A Morton, M D, Columbia Hospital Milwaukee Meets monthly on first Friday

Radiological Section of the Wisconsin State Medical Society—*Secretary* Russel F Wilson, M D, Beloit Municipal Hospital, Beloit Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society in September

University of Wisconsin Radiological Conference—*Secretary*, E A Pohle M D, 1300 University Ave Madison Wis Meets every Thursday from 4 to 5 P.M Room 301 Service Memorial Institute

the transfer is easily made. As advantages we must mention the extreme clearness of the images, the slightest details of which are brought out, furthermore, each image of the original film constitutes an ordinary roentgenographic document which may be studied at leisure.

III OUTLOOK FOR THE FUTURE

At the Radiologic Congress in Vienna, last September, the great question of roentgen cinematography was the order of the day. There the consensus was, notwithstanding the technical efforts of the last few years, of which the indirect method was the only one to profit, that the method had not made any important progress since the International Congress of Zurich. Practically speaking, the abdominal organs always escape investigation, as might have been foreseen from the shortcomings of roentgenoscopy, upon which the method is based.

The direct method, on the contrary, has already proved the important rôle it is capable of playing, as has been shown by its application to the study of normal and pathologic physiology of the urinary tract (plenary session of the International Con-

gress of Vienna, September, 1936).³ The revelations that this method has brought to the study of the urinary function can be brought to the study of other organs also: gall bladder, rugæ of the gastric mucous membrane, arteriography, encephalography, etc. Up to the present time, direct roentgen cinematography has not profited by any technical progress, but I expect soon to do away with the obturator by interrupting the emission of the rays, during the displacement of the film, by so doing, the exposure can be doubled without affecting the tube.

This modification will permit the use of tubes with a focus of from 1 to 2 mm, as the necessary changes are weak, and, thanks to the fineness of this focus, the use of the anti-diffusion grid may be discontinued. In closing, let us hope that the tube manufacturers will adapt their tubes to roentgen cinematography. By improving the cooling of the anti-cathodes, they will permit longer exposure or greater intensity, preserving at the same time these tubes for the routine work of the laboratory.

³ Title of the paper: *La radiocinematographie directe* du Dr. Van de Maele appliquée à l'étude de la physiologie normale et pathologique des voies urinaires, par le Dr. F. Stobbaerts, urologue à Bruxelles.

tion is clearly not indicated. An example of this group is a small, localized, definitely operable carcinoma treated by the radical surgical operation in which the clinical findings, operative findings, and pathologic examination combined to indicate that the local disease has, in all probability, been removed. If the axillary lymph nodes are not involved microscopically, this supposition is greatly strengthened. Even in the presence of microscopically involved lymph nodes, however, local recurrence in the axilla almost never occurs following complete axillary dissection when the lymph nodes are small, movable, and have not extended to the apex of the axilla.

(2) Cases in which prophylactic post-operative irradiation is clearly indicated. Examples are cases in which the operation has been inadequate, or in which the completeness of the operation is in doubt, also cases in which the lesion was considered to be operable and found at operation to have been inoperable, or cases in which clinical and pathological evidence indicate that the carcinoma is of the type which has a tendency to wide subdermal lymphatic permeation.

(3) A borderline group in which the treatment of each case has to be decided upon its own merits, taking into consideration all factors including the age of the patient, her general condition, and co-existing disease.

The question naturally arises as to whether, instead of attempting to select the cases in which post-operative irradiation therapy is indicated, it may not be safer to treat the entire group. The argument against this attitude may be stated as follows. A complete cycle of prophylactic post-operative irradiation with adequate doses cannot be regarded as an entirely harmless procedure. The age of the patient and complicating diseases must be taken into consideration. Thus, if a radical operation has been performed upon a strictly operable and localized carcinoma of the breast and the axillary lymph nodes are found to be free of metastasis microscopically, and the patient is either very old or suffering from one of the constitutional diseases, post-operative irradiation is clearly contra-indicated for the chances of local recurrence under these conditions are so slight and the increased chances of cure so small that it does not seem reasonable to risk upsetting the patient's general condition for these indefinite and limited advantages. It seems more logical to weigh

the opposing factors in each case before a decision is made and ask the question whether the chances of local recurrence and increased curability as indicated by the clinical and pathological evidence are greater than the risk involved.

MAX CUTLER, M.D.

21 West Elm Street, Chicago, Illinois

ANNOUNCEMENTS

NEXT ANNUAL MEETING

The meeting, as already announced, will be held at Pittsburgh, Pennsylvania, in the Hotel William Penn, from Sunday, November 27, through Friday, December 2, 1938.

The usual routine of the Scientific Sessions will be varied somewhat this year from that of recent years. The morning sessions will be held in the Main Assembly Hall and will consist of papers on general subjects, as usual. In the afternoons there will be two sessions, running simultaneously in two rooms, devoted to Diagnosis and Therapy, respectively. The afternoon sessions will be devoted exclusively to symposia under the leadership of ten outstanding radiologists.

Following the afternoon Scientific Sessions there will be a series of one-hour clinics on various subjects. In some instances these will supplement the papers given in the general sessions where the time is necessarily limited.

An innovation this year will be the so called "Refresher Courses" which are intended to thoroughly review the fundamentals of certain subjects by men of national reputation along these lines. These will be under the direction of the Publicity and Educational Committee of which Lewis G. Allen, M.D., is chairman. Further details of these will be given in a later issue.

Those desiring to present contributions for the general program should get in touch with the Program Committee.

AMERICAN RADIUM SOCIETY

The Thirty-third Annual Meeting of the American Radium Society will be held in San Francisco, June 13-14, 1938. Headquarters for the meeting, the dinner, and the Janeway Lecture will be at the Clift Hotel, Geary and Taylor Streets.

point the fact that there are several tumors instead of one indicates in a broader sense that multiplicity of tumors constitutes a malignant element as compared to singularity of tumors. On the other hand, from my records bladder carcinomas are usually single. The following table emphasizes this

CONTROLLED CASES	
Single	73
Multiple	23
UNCONTROLLED CASES	
Single	88
Multiple	35
CARCINOMA REGISTRY GRADED CASES	
Controlled cases	47
Uncontrolled cases	66

FACTORS INFLUENCING TYPE OF THERAPY

(A) *Size of Tumor*—Small tumors, papillary or infiltrating, are best treated cystoscopically by radon seeds implanted or radon applications. Large tumors, if papillary, are treated by suprapubic radon implants. Large tumors if infiltrating, are treated by methods outlined below.

(B) *Grade of Tumors*—Lower grades of malignancy (I and II) are treated as above outlined. Higher grades of malignancy, particularly Grade IV, are treated, if possible, by external irradiation and cystoscopy.

(C) *Position of Tumors*—When tumors of the bladder base (75 per cent of all bladder tumors) are encroaching upon the ureters or internal urethra, radiation therapy is superior to operative removal.

(D) *Condition of Kidneys*—If the kidneys are infected, the ureters and kidney pelvis dilated, then cystoscopic treatment by radium is superior to the open operation. The suprapubic operation and the massive implantation of radon seeds add to the infection. The implantation or application of radium cystoscopically can be done in divided treatments.

Comparison between Surgical and Radiation Results—Probably the best surgical five-year results in bladder cancer are 25 per cent controls. These surgical results

are computed on the total number of cases in which the tumor could be removed surgically. Obviously there are a large number of cases in which surgical intervention is impossible, and which the surgical statistics do not include. Our radiation statistics include all cases in which the cancer is believed to be confined to the bladder. The size of the carcinoma has not prevented an attempt to cure it. The radiation results, if we can report 24 per cent five-year cures, must obviously be better than the surgical results.

Disadvantage of Radium Treatment—The implantation of seeds into an infected tumor increases the amount of infection present. A slough is always formed and this presents a focus of increased infection. This slough may become incrustated with calcareous deposits and stone formation may result. Asepsis and a certain amount of antiseptics helps obviate this condition. Cleansing of the bladder with antiseptic washes before and after cystoscopic implantation, extreme care in the suprapubic approach, and painting of the tumor base with mild solutions of iodine before radium implantation all help. If the tumor is badly infected, however, nothing will prevent severe infection and cystitis and bilateral pyelonephritis.

Vesico-vaginal fistula in female patients occurs. I have had three such in the above series: one is dead, one lived five years and then died of an acute kidney flareup, one has gone about two years and is reasonably comfortable after a skin implantation of the dilated ureter of her single kidney.

Suprapubic versus Cystoscopic Radiation—Not only the size of the tumor but the infection of the tumor and the condition of the kidneys should determine the method of treatment, whether suprapubic or cystoscopic. We are steadily leaning more and more toward the cystoscopic treatment. If the tumor is ulcerated and infected and if the kidneys are hydronephrotic, the suprapubic implantation of a large amount of radon is a dangerous procedure from the infection standpoint.

The book is written in a humorous vein which makes reading it a delight, and it is well illustrated with amusing drawings. Whimsical and instructive, this little volume should be required reading for all technicians and nurses who handle radium. Its study would serve to prevent much of the loss, worry, and work connected with the search for and recovery of lost radium.

DAS VENTRIKULOGRAMM (The Ventriculogram)

By ERIK LYSHOLM, Dozent für Medizin, Radiologic, BERTIL EDENIUS, and HANS SAHLSTEDT, Assistenten am Röntgeninstitut Part II, DIE SEITENVENTRIKEL (The Lateral Ventricles) Supplement XXV, Acta Radiologica. A volume of 199 pages, with 284 illustrations. Published by P. A. Norstedt & Sons, Stockholm, Sweden, 1937. Price 15 Kr (\$4.20).

Although this monograph is identified as Part II of Lysholm's series on ventriculography, it is the last of a group of three volumes to appear. This phase of the subject has been considered in the same concise and practical manner as in the antecedent volumes. Collectively these three volumes constitute the most practical and informative text on ventriculography that has appeared in any language. American readers will find the German text easy to translate and well worth the effort involved.

To facilitate the discussion of tumors affecting the lateral ventricles, Lysholm has classified the material in the following manner:

(A) Convexity tumors (without displacement of the temporal horns)

I Medial or Parasagittal Tumors

Group I Anterior frontal tumors
Group II Posterior frontal tumors

Group III Fronto-parietal tumors
Group IV Parietal tumors

Group V Occipital tumors

II Lateral Tumors (including tumors of the fissure of Sylvius)

(B) Basal Tumors (including temporal tumors)

I Subfrontal
II Supra- and intrasellar
III Anterior temporal
IV Posterior temporal

(C) Central Tumors (from the corpus striatum, thalamus and their immediate vicinity)

(D) Intraventricular Tumors

(E) Tumors originating from the septum pellucidum and corpus callosum

Each classification and group is discussed individually, giving significant statistics, general ventriculographic characteristics, and summaries of typical cases together with ventriculograms and tracings. It is difficult to see how this important subject could be presented in a more logical and instructive manner. The illustrations are excellent and the whole manner of presentation is a tribute to a good teacher who knows his subject.

TRAUMATISMES DU PIED ET RAYONS X (Traumatism of the Foot and the X-rays) By ETIENNE DESTOT. Preface by Dr ALEXIS CARREL. Second Edition. A volume of 292 pages, with 156 figures. Published by Masson et Cie, Paris, 1937. Price 45 fr.

This volume was first conceived and written by Destot some years ago. He, having died in 1918 at Chatillon-sur Seine, the material laid unpublished. With the permission of Madame Destot, Gallois and Japiot have edited the material, the text being as nearly as possible as originally written, these pupils of Destot having added only some roentgenograms.

The author first gives an extensive discussion of the bony anatomy of the foot and leg, then goes on to a rather extensive classification of fractures of the malleoli. This is followed by a chapter in which he discusses the pathogenesis

Group I Anterior frontal tumors { originating from the anterior one-third of the longitudinal sinus

Group III Fronto-parietal tumors { originating from the mid one-third of the longitudinal sinus

Group V Occipital tumors { originating from the posterior one-third of the longitudinal sinus

of these fractures and a discussion of the acute fractures of this region. This subject is very extensively discussed and while the terminology and nomenclature used are somewhat at variance with ours, yet the subject material is there and well presented and illustrated.

The author then goes on to a discussion of old fractures about the ankle. The various

CASE REPORTS AND NEW DEVICES

A REFLECTING PHOTOELECTRIC ERYTHEMA EVALUATOR

A PRELIMINARY REPORT

By O. R. TROJE, M.D., *Fairfield, Alabama*

Spectrophotometric color analysis is, of course, not new and is said to have been first used by Sheard and Sanford, of the Mayo Clinic, in 1928, for hemoglobin estimations

gets close enough for practical purposes. It may have a potentiometer across one of the end cells. Other solutions would be the constant wattage transformer or some of the V T voltage regulating devices now on the market.

The principle of operation depends entirely on the current fluctuation produced in a barrier plane type photoelectric cell by the variations in intensity of luminosity striking its surface, due to the variations in skin shade

WIRING DIAGRAM

A REFLECTING PHOTOELECTRIC ERYTHEMA EVALUATOR

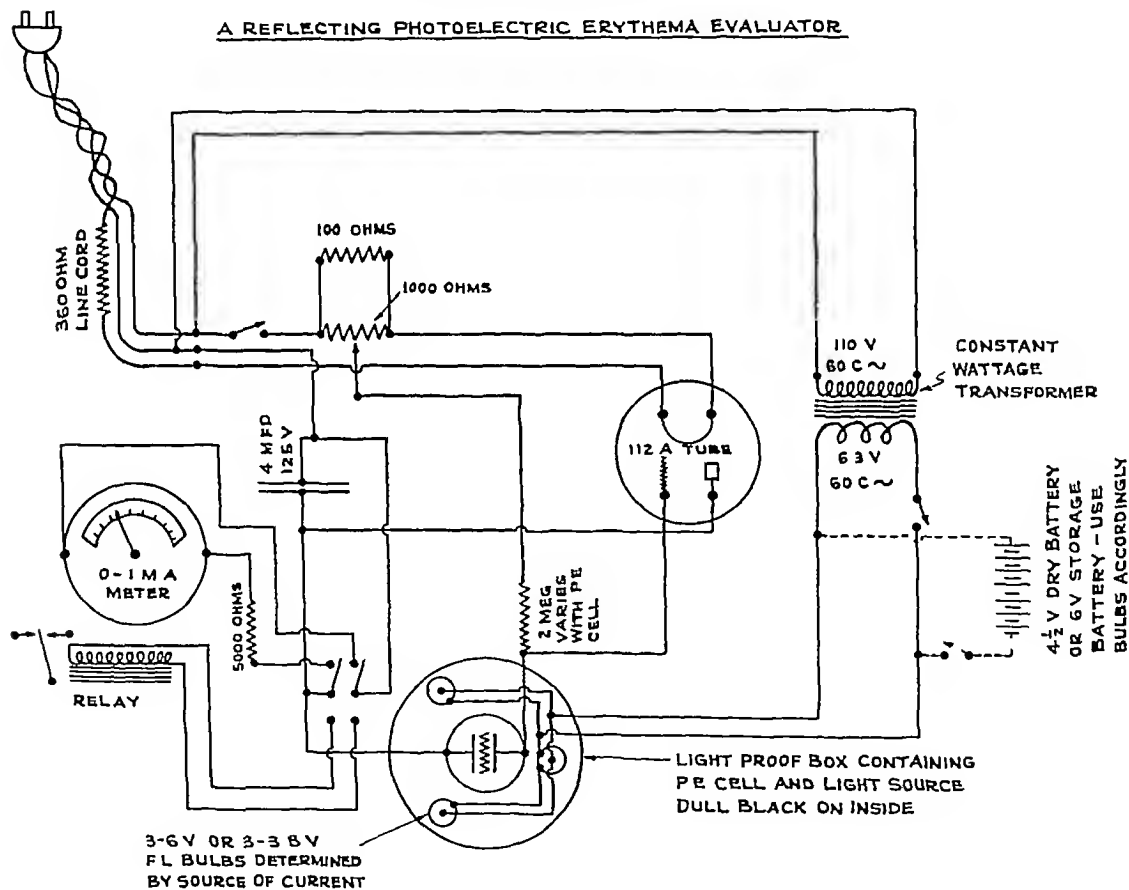


Fig 1

Their method was possibly an adaptation from the industrial field to the clinical laboratory, while mine is merely an attempt to make practical use of the same principle in the radiological field. Each method, of course, has its obstacles, the most important of which is the production of an unvarying base current and voltage *i.e.*, wattage. Perfection in this is obviously impossible, but the storage battery when in good condition and freshly charged

or complexion which are reflected into the photoelectric cell by an especially designed illuminator. The fluctuation is read off on a microampere meter properly inserted in the circuit. At present, I am still using a 0 to 1 milliamper meter with 5,000 ohms in series with the P E cell, and an ordinary Pesce Magnicell. By improving the quality of my units and increasing the resistances I will be able to get a response to much narrower dif-

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Gynecology and Obstetrics	775	Historadiography	777
Heart and Vascular System	776	Hodgkin's Disease	777
The Hip Joint	777	Infection	778
The Intestines			

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S M ATRINS M D, of Waterbury Conn	HANS W HEFKE M.D of Milwaukee Wis
S RICHARD BEATTY M D of Madison, Wis	A MAYORAL, M D of New Orleans La
G E BURCH, M D, of New Orleans, La	ERNST A POHLE, M D, Ph D, of Madison, Wis

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

ABAY JOSÉ with DÍAZ ROBERTO PÉREZ jt auth	778	LÉON RAFAEL RAMÍREZ with DÍAZ ROBERTO PÉREZ, jt auth	778
BARTSCH H, and WACHNER G Cardiovascular Complications	776	LEVY ROBERT L and GOLDEN, ROSS Roentgen Therapy of Active Rheumatic Heart Disease A Summary of Eleven Years Experience	776
BERGER JEAN GALLI and MIALARET J Radiologic Images of Small Intestinal Obstructions without Organic Obstruction	778	LUDWIG H Auricular Fibrillation in the Kymograph	776
BONNET L Kymographic Insufflation of the Tubes	775	MANGES WILLIS F with SMITH R MANGES jt auth	778
DÍAZ ROBERTO PÉREZ LEON RAFAEL RAMÍREZ and ABAY JOSÉ Intestinal Obstruction in a Fifteen year old Youth Caused by a Persistent Omphalomesenteric Duct	778	MIALARET J with BERGER JEAN jt auth	778
FRANCON, F The Radiographic Appearance of the Pseudo-cysts of Coxarthrosis	777	PRINZ H Hodgkin's Disease	777
GALLI with BERGER JEAN jt auth	778	REITZ M with GUTHMANN H jt auth	775
GOLDEN ROSS, with LEVY ROBERT L jt auth	776	SCHAAP C Spontaneous Separation of Symphysis Pubis	776
GUTHMANN H and REITZ M Heat Effect and Results of Short Wave Therapy in Gynecological Diseases	775	SMITH R MANGES and MANGES WILLIS F Roentgen Treatment of Infection from Human Bite	778
HEYNEMANN T Adrenal Tuberculosis	775	SNOW WILLIAM The Postural Treatment of Infant Colic	778
IVERSEN, S C Infantile Coxitis and its Sequels	777	SOLEIL G Right sided Descending Aorta	776
KORB H Short Wave Therapy in Gynecology	775	TILLIER H Aortic Calcification Simulating Ureteral Calculus in a Case of Renal Lithiasis	776
V KÖVESLIGETHY BÜBEN I Present day Problems of Short Wave Therapy in Gynecology	775	VOGT EDWARD C Congenital or Infantile Dislocation of the Hips	777
LAMARQUE PAUL Possibilities of the Extension of Methods of Micro-analysis by Historadiography	777	WACHNER G with BARTSCH H, jt auth	776

tient, establishing a "zero" on the skin of her as yet unirradiated breast.

In closing, let me say that while I hope this idea has some originality and merit I make no claims of any kind, but am offering this preliminary report more for the purpose of calling it to the attention of others better qualified than myself. They can judge whether or not this apparatus has possibilities and if the so-called erythema dose of to-day could, by eliminating the personal equation, be given a real meaning

ANCIENT ARTHRITIS

By E BURNHAM CHAMBERLAIN Curator of
Mammals Charleston Museum
and

ROBERT B TAFT, M D Charleston, South Carolina

While it is well known that arthritis is a very old disease, having been found in the skeletons of ancient man, the finding of evidence of this disease in what may well be called the shadowy past seems worthy of note

In October, 1937, the Charleston Museum received two large molar teeth dug up on John's Island, near Charleston, S C. The digging of a boat slip on the edge of a salt water creek had brought to light a number of fragments of bone, some molar teeth, and parts of tusks. Investigation and subsequent excavation disclosed a deposit of broken bones and a few molars of a mastodon, *Mammut sp.*, lying on the creek edge near the low water mark, and at a depth of approximately six feet. The fossiliferous layer is composed of silt with considerable vegetable matter present, above this bed is a three-foot stratum of hard sand, this in turn being topped with about three feet of marsh-bearing mud. The bones of this deposit were so soft that removal proved difficult. That the animal was an old adult is evidenced by the worn condition of the molars, its age is placed as late as, if not post-, Pleistocene.

The fossil elephants, both mastodons and mammoths, were widely distributed both in time and space, the former known from the mid-Miocene (about ten million) to the end of the Pliocene (about one to six million) years ago, in the Old World, and until the late Pleistocene in America. The Pleistocene period is considered by geologists to have covered from ten thousand to one million years. Remains have been found in Europe, Asia, and North America. Certain it is that early man knew these huge animals, and there is ample evidence of their contemporary existence, at least in the Old World. Now it appears that early man and the mastodon had more in common than mere acquaintanceship, as this particular beast



Fig 1

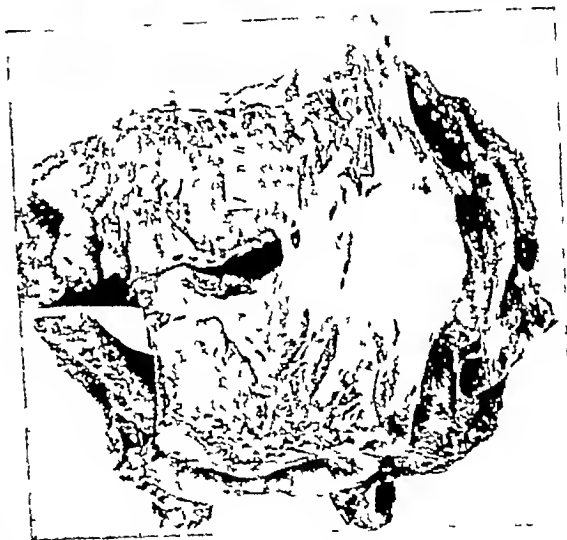


Fig 2

suffered from osteo-arthritis of the same type seen by every radiologist to-day

In excavating some of the above-mentioned material, we uncovered two thoracic vertebrae lying together as if in their original position. On removing the surrounding mud and sand, we found that these vertebrae were connected by a broad band of bone between their ventral surfaces. A radiograph (Fig 1) showed this connecting band definitely to be of bone, eliminating all reasonable doubt as to the diagnosis. The splintered appearance is probably due to the drying out after removal from the mud. The photograph (Fig 2) shows the specimen in the same position as seen in the radiograph. Several of the ribs showed heavy proliferation of the cortex. Many other fragments of the skeleton show similar changes though to a lesser

Clinic at the University of Budapest Of the 311 cases of pelvic inflammatory disease, 102 were acute and subacute and 209 chronic Of the first group 80 per cent were cured and of the second group 87 per cent The condenser field method was used with the electrodes at 5 to 10 cm from the skin Applications varied from 5 to 20 minutes, depending on the acuteness of the inflammation

A study was also undertaken in order to determine the effect of short wave therapy on menstruation Seventy eight test cases were used in 72 per cent the period was normal, in 14 per cent there was slightly more bleeding, and in 12 per cent the period lasted longer It is concluded, therefore, that short wave therapy is not contra indicated during the menstrual period Ninety six cases of dysmenorrhea were also treated and in 70 per cent there was improvement or cure Individualization of the therapeutic approach is important and the dosage must be carefully controlled

ERNST A. POHLE M.D. Ph.D.

Spontaneous Separation of Symphysis Pubis C. Schaap Ned. Tijdschr. v. Geneesk., May 29, 1937 pp. 2510-2514 (Reprinted by permission from British Med. Jour., July 24, 1937 page 16 of Epitome of Current Medical Literature)

The author, who records an illustrative case, states that spontaneous symphysiolysis is a very rare occurrence Wislone and Mayer quote three series of statistics according to which it was seen only once in 30,000 deliveries, four times in 80,000 and three times in 94,000 During pregnancy, owing to the increased blood supply in the pelvis, the ligaments of the different joints become loose, so that an increased mobility of the symphysis and sacral joints develops and the symphysis can be moved 5 mm in a horizontal and vertical direction The symptoms are as follows (1) There is pain in the symphysis and lower part of the back, sometimes radiating down the thighs, (2) the patient is unable to lift or move the legs, and (3) she has a waddling gait These symptoms are so characteristic that the diagnosis can be made without x ray examination Treatment should always be conservative consisting of absolute rest in bed for from four to six weeks according to the severity of the case. Schaap's patient, in whom spontaneous symphysiolysis occurred during delivery was a woman, 25 years of age, in whom spontaneous necrosis had occurred in the mesial sesamoid bone of the left hallux a year previously

HEART AND VASCULAR SYSTEM

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evidence of improvement in a large number of these patients, those receiving the largest doses were most benefited Irradiation relieved cardiac pain in patients who did not have aortic insufficiency There were no harmful effects noted, although unpleasant radiation reactions appeared in about one-half the cases. The patients with low grade activity and free from any evidence of congestive heart failure fared best. The nature of the benefits produced by irradiation therapy is unknown The method promises to be of some significance in the treatment of properly selected cases.

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A case of right sided descending aorta is presented which is evidently not due to congenital anomaly, but to a combination of syphilitic aortitis with elongation and a left kyphoscoliosis

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HANS W. HEFKE, M.D.

Cardiovascular Complications H. Bartsch and G. Wachner Klin. Wchnschr., May 23, 1937, 16, 743-746 (Reprinted by permission from British Med. Jour. Aug. 14, 1937, page 27 of Epitome of Current Medical Literature.)

The authors describe the effects on the cardiovascular system which they were able to observe in a large proportion of cases of carcinoma of the pharyngo-laryngeal region treated by Coutard's method of protracted and parcelled deep x radiation. The complications were caused by the toxic products of the irradiated tissues, and manifested themselves in myocardial degeneration and disturbances of the cardiac rhythm. The fall of the blood pressure and the acceleration of the pulse may lead to coronary insufficiency in cases predisposed to angina pectoris. The authors therefore, advise careful observation of the cardiovascular system and appropriate prophylactic measures in all cases treated by Coutard's method.

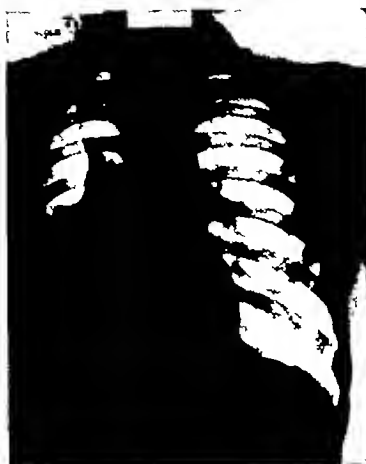


Fig 4 Hydro-pneumothorax, lung expanded slightly, fluid on shelf like projections of pleura (May 1 1937)



Fig 5 Almost complete expansion of the middle and upper lobes, slight amount of fluid in the pleural sac (May 26, 1937)

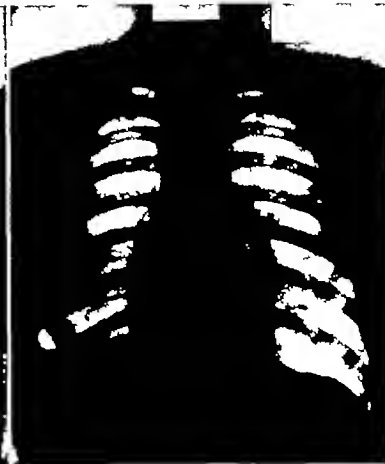


Fig 6 Right lung fully expanded except for some limitation of the diaphragm, no fluid patient in good health (June 11, 1937)

pulse, 90, respiration, 20 These became normal Bloody fluid was withdrawn on several occasions by paracentesis, 2,660 c c was recorded, and replaced by a smaller amount of air No organisms were found Smear and culture were repeated Bloody fluid became a transudate after paracentesis Gradual return of the right chest to nearly normal condition Roentgen examination was recorded in films reproduced as Figures 4, 5, and 6

The patient was discharged from the hospital on May 5, 1937, improved He continued to rest at home for several weeks His recovery is complete at the present writing (Aug 10, 1937)

SUMMARY

The above findings are brief conclusions based on the clinical record and the study of the roentgen examinations at different intervals It is quite evident that at the time of the accident there was severe injury to the right chest wall and diaphragm Under great pressure a quantity of air was forced from the lung into the chest wall, but the lung and pleura closed after the escape of air Blood slowly accumulated beneath the right diaphragm, causing the elevation Improvement was taking place, with absorption of the blood and return of the diaphragm to normal Suddenly, one month later, a severe hemorrhage occurred, filling the right pleural cavity and collapsing the lung, accompanied by much shock After paracentesis, repeated several times, the lung expanded and the remaining fluid was subsequently absorbed There has been almost complete return to normal in the function of the lung, pleura, and diaphragm

This case is unusual in that (1) emphysema occurred in the chest wall without collapse of the lung, that (2) hemorrhage into the pleural cavity took place a month later, and (3) full recovery has followed

OBJECT RECONSTRUCTION BY PLANIGRAPHY RECONSTRUCTION AND LOCALIZATION OF PLANES

By JULIUS KAUFMAN, M D, Brooklyn, N Y

Any object may be considered the integration of its constituent, serially juxtaposed, parallel planes By planigraphy (1, 2) it is possible to delineate from two or more radiographs all the plane images of an object, to determine their depths, and finally to reconstruct the actual planes By relocating the reconstructed planes (plane localization) in their relative positions in space, it is possible to reconstruct the object radiographed

The manner in which plane images are delineated and their depths determined has previously been described (1) The author's method of plane reconstruction (2), however, did not include plane localization Since it is necessary to localize planes, as well as reconstruct them, to accomplish object reconstruction, the previous method of plane reconstruction falls short of the goal desired To accomplish this we found it necessary to evolve an original, simple, graphic procedure which not only accomplishes plane reconstruction, but plane localization as well

In Figure 1, image A 1-B 1-C 1 represents the plane image (obtained by planigraphy,¹) of

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are reconstructed and transcriptions relocated in space, so that when a sufficient number have been so reconstructed, and localized, they may be said to represent the actual reconstruction of the object radiographed

REFERENCES

- (1) KAUFMAN, JULIUS Planigraphy, Localization and Mensuration "Standard Depth Curves" RADIOLOGY, August, 1936, 27, 168
 - (2) Idem The Planigram RADIOLOGY, December 1936, 27, 732
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